Standard of the Camera & Imaging Products Association

CIPA DC- 008-Translation-2023

Exchangeable image file format for digital still cameras:
Exif Version 3.0

This translation has been made based on the original Standard (CIPA DC-008-2023).
In the event of any doubts arising as the contents, the original Standard is to be the final authority.

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CP-3451F Exchangeable image file format for digital still cameras: Exif Version 3.0

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Contents

Introduction 12

Revision History 13

1. Scope 16

2. Definitions 17

2.1. Definition of Terms 17

2.2. Verbal forms for the expression of provisions 18

3. General 20

3.1. Format Structure 20

3.2. Exif Image File Specification 20

3.3. Exif Audio File Specification 21

3.4. Relation between Image and Audio File Specification 21

3.5. Presupposed Systems and Compatibility 21

3.6. Workflow for editing an image with application software 22

3.6.1. Actions 23

4. Exif Image File Specification 24

4.1. Outline of the Exif Image File Specification 24

4.2. Format Version 24

4.3. Definition of Glossary 24

4.4. Specifications Relating to Image Data 24

4.4.1. Number of Pixels 24

4.4.2. Pixel Aspect 25

4.4.3. Pixel Composition and Sampling 25

4.4.4. Image Data Arrangement 26

4.5. Basic Structure of Image Data 27

4.5.1. Basic Structure of Primary Image Data 27

4.5.2. Basic Structure of Uncompressed RGB Data 28

4.5.3. Basic Structure of YCbCr Uncompressed Data 30

4.5.4. Basic Structure of JPEG Compressed Data 30

4.5.5. Application marker segments 32

4.5.6. How to deal with APPn markers undefined in the Exif standard 34

4.5.7. Recording data other than the primary image 35

4.5.8. Basic Structure of Thumbnail Data 35

4.6. Tags 36

4.6.1. Features of Attribute Information 36

4.6.2. IFD Structure 37

4.6.3. Exif-specific IFD 38

4.6.4. Character Identifier Code 39

4.6.5. TIFF Rev. 6.0 Attribute Information 41

4.6.6. Exif IFD Attribute Information 54

4.6.7. GPS Attribute Information 90
4.6.8. Interoperability IFD Attribute Information 100
4.6.9. Tag Support Levels 101
4.7. JPEG Marker Segments Used in Exif 108
4.7.1. JPEG Marker Segments 108
4.7.2. Internal Structure of APP1 in Compressed Data 113
4.7.3. Internal Structure of APP2 for Flashpix in Compressed Data 114
4.7.4. Internal Structure of APP2 for Original Preservation Image in Compressed Data 118
4.7.5. Internal Structure of APP11 in Compressed Data 118
4.8. Data Description 122
4.8.1. Stipulations on Compressed Image Size 122
4.8.2. Stipulations on Thumbnails 125
4.8.3. File Name Stipulations 126
4.8.4. Byte Order Stipulations 126

5. Exif Audio File Specification 127

5.1. Outline of the Exif Audio File Specification 127
5.2. Format Version 127
5.3. Definition of Terms 127
5.4. Specifications Relating to Audio Data 127
5.4.1. Sampling Frequency 127
5.4.2. Bit Size 128
5.4.3. Channels 128
5.4.4. Compression Schemes 128
5.5. Basic Structure of Audio Data 128
5.5.1. Basic Structure of WAVE Form Audio Files 128
5.5.2. Basic Structure of PCM Audio Data 135
5.5.3. Basic Structure of μ-Law Audio Data 140
5.5.4. Basic Structure of IMA-ADPCM Audio Data 142
5.6. Chunks Used 147
5.6.1. WAVE Form Audio File Basic Chunks 147
5.6.2. LIST Chunk and INFO List 147
5.6.3. Chunks for Attribute Information Specific to Exif Audio Files 153
5.7. Data Description 157
5.7.1. File Naming Stipulation 157
5.7.2. Typical Exif Audio File 158

6. Box Format Metadata 160

6.1. Metadata Types 160
6.2. Annotation Data 160
6.2.1. Overview 160
6.2.2. Description Language 160
6.2.3. Annotation Description Method 160

7. Logo Mark Guidelines 179

8. References 180

Annex 184

Annex A. [Informative] Image File Description Examples 185

A.1 Uncompressed RGB File 185
A.2 Uncompressed YCbCr File 188
A.3 JPEG Compressed (4:2:2) File 195
A.4 JPEG Compressed (4:2:0) File 200

Annex B. [Informative] Audio File Description Examples 207

B.1 PCM Audio Data 207
B.2 μ-Law Audio Data 209
B.3 IMA-ADPCM Audio Data 212

Annex C. [Informative] APEX Units 215

Annex D. [Informative] Color Space Guidelines 216

Annex E. [Informative] Guidelines for Implementing Tag Information 217

E.1 General 217
E.2 Tag Use in Exif/DCF Readers 217
E.2.1 ExposureTime 217
E.2.2 BrightnessValue 217
E.2.3 LightSource 218
E.2.4 Flash 218
E.2.5 SubjectArea 218
E.2.6 CustomRendered 219
E.2.7 ExposureMode 220
E.2.8 WhiteBalance 220
E.2.9 DigitalZoomRatio 220
E.2.10 FocalLengthIn35mmFilm 221
E.2.11 SceneCaptureType 221
E.2.12 GainControl 222
E.2.13 Contrast/Saturation/Sharpness 222
E.2.14 SubjectDistanceRange 223

Annex F. [Informative] Notes on Conversion to Flashpix 224

F.1 Converting Image Data 224
F.2 Converting Tag Data 226
F.3 Converting to Flashpix Extensions (APP2) 230

Annex G. [Informative] Use of Sensitivity-Related Tags 232

Annex H. [Informative] Guidelines for Handling Tag Information in Post-processing by Application Software 234

H.1 Introduction 234
H.2 Exif Tag Classifications 234
H.3 Post-processing Ranks of Exif Tags 235
H.4 Category and Rank Relationship 236

H.5 Possibility of Identifying or Inferring Sensitive Information Related to Individuals, Organizations, etc. 237
H.6 Tag Categories and Ranks 238

Annex I. [Informative] Vocabulary Specifications 243

Annex J. [Informative] Examples of Annotation Description 245
J.1 Description Examples 245
J.2 Example of Description in JSON-LD Form 246
J.3 Example of Description in XML Form 247

Annex K. [Normative] Original Preservation Image 249
K.1 Concept and Purpose 249
K.2 Specifications 249
K.2.1 Overview 249
K.2.2 General Rule 249
K.2.3 Definition of Terms 249
K.2.4 Option 250
K.2.5 Individual Image Attribute 250
K.2.6 Baselin MP File 250
K.2.7 Dependent Relationship 251
K.2.8 Specification Related to MP Format Attribute Information 251
K.2.9 Padding 251
K.2.10 Exif Thumbnails 251
K.2.11 Number of Pixels 251
K.2.12 Sameness with Baseline MP Primary Image 251
K.2.13 Exif Tag Description Level of Original Preservation Image 252

Participating members 254

Table and Figure

Table 1 TIFF Headers 30
Table 2 Marker segments of JPEG compressed data in Exif 32
Table 3 Combinations of primary image and thumbnail data structures 36
Table 4 Character Codes and Character Code Designations 40
Table 5 Differences Between Defined and Undefined Character Code Implementation 40
Table 6 TIFF Rev. 6.0 Attribute Information Used in Exif 41
Table 7 Relationship between column count/row count of coded image data and Exif tag 44
Table 8 Exif IFD Attribute Information (1) 54
Table 9 Exif IFD Attribute Information (2) 56
Table 10 Mapping between Image and Audio Files 61
Table 11 Example of Exposure and RGB Output Level 66
Table 12 Example of Spatial Frequency Response 74
Table 13 Color Filter Color and CFA Value 77
Table 14 GPS Attribute Information 90
Table 15 Setting of each positioning method 99
Table 16 Interoperability IFD Attribute Information 100
Table 17 Tag Support Levels (1) - 0th IFD TIFF Tags – 101
Table 18 Tag Support Levels (2) - 0th IFD Exif Private Tags – 102
Table 19 Tag Support Levels (3) - 0th IFD GPS Info Tags - 105
Table 20 Tag Support Levels (4) - 0th IFD Interoperability Tag – 106
Table 21 Tag Support Levels (5) - 1st IFD TIFF Tag - 106
Table 22 Marker Segments 108
Table 23 Typical Width Direction Information and Padding Data 124
Table 24 Typical Height Direction Information and Padding Data (when Y:Cb:Cr = 4:2:2) 125
Table 25 Representative Form Types 130
Table 26 Format Information Members 132
Table 27 fact-ck Member 134
Table 28 PCM Format fmt-ck Information 136
Table 29 Sample Data Formats and Values 138
Table 30 fmt-ck and fact-ck Information in μ-Law Format 141
Table 31 IMA-ADPCM Format fmt-ck and fact-ck Information (1) 143
Table 32 IMA-ADPCM Format fmt-ck and fact-ck Information (2) 145
Table 33 INFO List Chunks 148
Table 34 Mapping between Image and Audio Files 155
Table 35 Box Format Metadata 160
Table 36 ANW or ANH Value and Position Meaning 162
Table 37 Area Types, Tag Names, and Coordinate Expressions 163
Table 38 Layer Structure 178
Table 39 Uncompressed RGB File Description Sample Contents 185
Table 40 Uncompressed RGB File Description Sample 186

Table 41 Uncompressed YCbCr File Description Sample Contents 188
Table 42 Uncompressed YCbCr File Description Sample 190
Table 43 JPEG Compressed (4:2:2) File Description Sample Contents 195
Table 44 JPEG Compressed (4:2:2) File JPEG Stream Description Sample 196
Table 45 JPEG Compressed (4:2:2) File APP1 Description Sample 197
Table 46 JPEG Compressed (4:2:0) File Description Sample Contents 200
Table 47 JPEG Compressed (4:2:0) File JPEG Stream Description Sample 201
Table 48 JPEG Compressed (4:2:0) File APP1 Description Sample 203
Table 49 PCM Audio File Description Sample Contents 207
Table 50 PCM Audio File Description Example 207
Table 51 μ-Law Audio File Description Sample Contents 209
Table 52 μ-Law Audio File Description Sample 210
Table 53 IMA-ADPCM Audio File Description Sample Contents 212
Table 54 IMA-ADPCM Audio File Description Example 212
Table 55 Typical APEX Values 215
Table 56 Relation between Custom Rendered and Output device process 219
Table 57 Examples of Processing for Different Scene Types 221
Table 58 Examples of Processing to be avoided by Exif/DCF Readers 223
Table 59 Conversion between Exif Tags and Flashpix Property Set (1) (TIFF Tags) 226
Table 60 Conversion between Exif Tags and Flashpix Property Set (2) (Exif Private Tags) 227
Table 61 Conversion between Exif Tags and Flashpix Property Set (3) (GPS Info Tags) 229
Table 62 Exif Tag Classifications 234
Table 63 Post-processing Ranks 235
Table 64 Categories and Ranks of 0th IFD TIFF Tags 238
Table 65 Categories and Ranks of 0th IFD Exif Private Tags 239
Table 66 Categories and Ranks of 0th IFD GPS Info Tags 241
Table 67 Categories and Ranks of 0th IFD Interoperability Tag 242
Table 68 Overlap of Controlled Terminology Established by Major Organizations 243
Table 69 MP Types 251

Figure 1 Format structure 20
Figure 2 Compatibility Concepts 22
Figure 3 Editing images with application software 23
Figure 4 Pixel Composition and Pixel Sampling 26
Figure 5 Data Arrangement 27
Figure 6 Basic Structure of Uncompressed Data Files 29
Figure 7 Basic Structure of Compressed Data Files 31
Figure 8 Structure of JPEG compressed data with added APPn in Exif (Example) 34
Figure 9 Structure of Exif file with compressed thumbnail 36
Figure 10 Configuration Example of Multicode Character Information Tag 40
Figure 11 Data array of an Exif image file 44

Figure 12 Orientation of an image display on a display device 44
Figure 13 Relationship between image data and orientation on a display screen according to an orientation tag.. 46
Figure 14 Relationship between the orientation tag and rotation processing to display image data on a screen ... 47
Figure 15 YcbCrPositioning 49
Figure 16 OECF Description 66
Figure 17 Bit Coding of the Flash Tag 71
Figure 18 Circular area designation 72
Figure 19 Rectangular area designation 73
Figure 20 Spatial Frequency Response Description 74
Figure 21 CFA Pattern Description 77
Figure 22 Color Filter Array 78
Figure 23 Format used to record picture-taking conditions 81
Figure 24 Format used to record SourceImageNumberOfCompositeImage 83
Figure 25 Format used to record SourceExposureTimesOfCompositeImage 84
Figure 26 SOI Structure 108
Figure 27 DQT Structure (with three quantization tables) 109
Figure 28 DHT Structure 110
Figure 29 DRI Structure 111
Figure 30 SOF Structure 111
Figure 31 SOS Structure 112
Figure 32 EOI Structure 112
Figure 33 Basic Structure of APP1 Marker Segment 113
Figure 34 Basic Structure of APP2 Marker Segment 115
Figure 35 Contents List Segment Structure 116
Figure 36 Stream Data Segment Structure 117
Figure 37 Structure of Reserved Segment for Flashpix 118
Figure 38 APP11 Internal Structure 119
Figure 39 Basic Structure of APP11 Marker 119
Figure 40 Structure of JUMBF BOX 120
Figure 41 Structure of JUMBF Description Box 121
Figure 42 Structure of JUMBF Content Box 122
Figure 43 Image Data Width Description 123
Figure 44 Image Data Height Description 124
Figure 45 Procedure for Image Data Reproduction 125
Figure 46 Chunk Structure 129
Figure 47 RIFF Chunk Structure 130
Figure 48 Data Structure of the WAVE Form Audio File Format 131
Figure 49 fmt-ck Structure 133
Figure 50 fact-ck Structure 134
Figure 51 data-ck Structure 135
Figure 52 Basic Structure of PCM Format 136
Figure 53 Packing of PCM Audio Data 140

Figure 54 Basic Structure of μ-Law Format 140
Figure 55 Packing of μ-Law Audio Data 142
Figure 56 Basic Structure of IMA-ADPCM Format 143
Figure 57 Packing of IMA-ADPCM Audio Data 146
Figure 58 Header Word of IMA-ADPCM Audio Data 146
Figure 59 Data Word M of IMA-ADPCM Audio Data 146
Figure 60 LIST Chunk Structure 148
Figure 61 Typical INFO List 151
Figure 62 Structure of User Comment Chunk 156
Figure 63 exif List Structure and Typical Coding 157
Figure 64 Exif Audio File Configuration 158
Figure 65 Data Structure of a Typical Exif Audio File 159
Figure 66 Annotation Data Configuration 161
Figure 67 Position of Area of Image When Adding Annotation 162
Figure 68 Rectangle Area - 1 166
Figure 69 Rectangle Area - 2 166
Figure 70 Point 168
Figure 71 Line 169
Figure 72 Polygon Area 171
Figure 73 Circle Area 172
Figure 74 Ellipse Area 174
Figure 75 Describing Multiple Sets of Attached Information 176
Figure 76 Specifying Multiple Independent Areas within Image 177
Figure 77 Overlapping Areas - 1: Specifying Area B in Area A 177
Figure 78 Overlapping Areas - 2: Specifying Area B Extending Across Area A 178
Figure 79 Conversion from Exif to Flashpix 224
Figure 80 Conversion to Flashpix Using Restart Markers 225
Figure 81 Image Size Restrictions 226
Figure 82 Conversion to Flashpix Extensions (1) 230
Figure 83 Conversion to Flashpix Extensions (2) 231
Figure 84 Conversion to Flashpix Extensions (3) 231
Figure 85 Annotation Description Sample Image 245
Figure 86 Example of JSON-LD 246
Figure 87 Example of XML 249

Introduction

This document is a standard that adds ability to record the case of an image generated by compositing method to “Exchangeable image file format for digital still cameras Exif 2.32” (specifically, CIPA DCG-008-2019 and JEITA CP-3451E; hereinafter called the “Exif Unified Version 2.32”) that was defined by JEITA and CIPA.

The following items were added in this revision:

1. Annotation Data definition and APP11 Marker Segment to store it (Optional)
   - Can record Annotation Data for any region in an image in XML or JSON format.

2. Original Preservation Image (Optional)
   - Can record and retain the original image at the time of capturing even after any post-processing.

3. New Tag Type for UTF-8
   - Can use more diverse characters in tags of character information by adding UTF-8 type as a unique Exif tag type. Since it can be selected and set (used together in a file) with existing ASCII type, it will be backward-compatible with existing devices and software.

4. [Exif IFD] Photographer Information and Software Information related Tags (Optional)
   - Can store individual tags for the Photographer, Image Editor, Camera Firmware, and Editing Software, etc., that could only be described within a single tag of mishmash, such as Artist Tag or Software Tag.

Revision History

Ver.	Date	Comment
1.0	October 1995	Published First Edition 1.0 ●Established image data format definitions ●Set definitions for structure of attribute information (tags) ●Established basic tag definitions
1.1	May 1997	Published Revision 1.1 ●Added tags ●Added operating specifications
2.0	November 1997	Published Revision 2.0 ●Added sRGB color space ●Added GPS ●Added compressed thumbnails and audio files
2.1	December 1998	Published Revision 2.1 ●Added DCF interoperability tags
2.2	April 2002	Published Revision 2.2 ●Applied ExifPrint - Developed tags for improving print quality (Photo contrast, sharpness, etc.) ●Added tags pertaining to positioning and GPS
2.21	September 2003	Published Revision 2.21 ●Added and corrected of Exif 2.2 content in line with revision of DCF 2.0 - Added notation of tags for Gamma, ColorSpace, etc., that correspond to optional color space - Changed content of notation of flash tags and FileSource tags ●Added operational guidelines(flash tags, scene capture type, etc) ●Corrected notation pertaining to image data pixel composition and pixel sampling ●Corrected misprints and omissions throughout the text

Unified Version 2.21	September 2009	Published Unified Version 2.21 ●Merged added/changed portion of Exif 2.21 to Exif 2.2 ●Corrected misprints and omissions throughout the text ●Added “Guidelines for Handling Exif/DCF” issued by CIPA (CIPA DCG-004-2009) as Annex G (at the time of publication) ●Added explication of 2.2 as Annex H (at the time of publication) ●Added explication of 2.21 as Annex I (at the time of publication)
2.3	April 2010	Published Revision 2.3 ●Restructured the main standard text, guidelines, explications, etc., of Exif Unified Version 2.21 ●Added and revised tags (Sensitivity-related tags, GPS information, camera and lens information, items pertaining to sound files, and light-source color) ●Clarified specification levels and revised the scope of application ●Supplemented explanations and adjusted format for the entire text
2.3 (Revised 2012)	December 2012	Published Revised Revision 2.3 ●Corrected an explanation part of Orientation Tag ●Corrected an explanation part of GPS Status Tag
2.31	July 2016	Published Revision 2.31 ●Added time difference to UTC(Universal Time Coordinated) as tags relating to Date and Time - Added three time offset tags respectively corresponding to the three existing tags (File change date and time, Date and time of original data generation, Date and time of digital data generation) ●Added tags relating to shooting situation (Temperature, Humidity, Pressure, WaterDepth, Acceleration, CameraElevationAngle) ●Corrected misprints and omissions throughout the text (Including the reflection of the contents of the corrigendum established in September 2014 to the main text)
2.32	May 2019	Published Revision 2.32 ●Added 3 tags relating to a composite image - CompositeImage, - SourceImageNumberOfCompositeImage, - SourceExposureTimesOfCompositeImage ●Renumbered according to the addition of figures

3.00	May 2023	Published Revision 3.00 ●Added Tag Type of UTF-8 as Exif specific taga type. - Enabled to select UTF-8 character string in existing ASCII-type tags ●Enabled APP11 Marker Segment to store a Box-structured data compliant with the JPEG System standard ●Added definition of Box-structured Annotation Data ●Added and changed the following tags - Added Title Tag - Added Photographer Information related Tags (Photographer and ImageEditor) - Added Software Information related Tags (CameraFirmware, RAWDevelopingSoftware, ImageEditingSoftware, and MetadataEditingSoftware) - Changed Software, Artist, and ImageUniqueID - Corrected incorrect definition of GPSAltitudeRef - GPSMeasureMode tag became to support positioning information obtained from GNSS in addition to GPS ●Changed the description support levels of the following tags: - XResolution - YResolution - ResolutionUnit - FlashpixVersion ●Discarded Annex E.3 to specifiy Application Software Guidelines ●Added Annex H. (at the time of publication) to specify Guidelines for Handling Tag Information in Post-processing by Application Software ● Added Annex I.and J. (both at the time of publication) for supplemental information of Annotation Data ●Added Annex K. (at the time of publication) to specify Original Preservation Image ● Corrected errors, typos and omissions accumulated up to this edition ●Restructured and revised the entire document structure and style

1. Scope

This standard specifies the formats of images, sounds, tags and other metadata that comprise the file for digital still cameras and other systems handling image or sound files recorded by digital still cameras.

Formats specified in this standard are defined as folder structures that are based on Exif-JPEG and recording formats for memory. When formats are used as Exif/DCF files together with the DCF Standard, which guarantees interoperability among devices of different types, their scope shall cover devices, systems, recording media, and application software that handle them. As devices mentioned above, the applicable items are devices with functions such as capturing, generating image data, recording, displaying, editing, and printing images.

Specifically, examples of capture/recording devices include DSCs, DVCs, and camera phones and smartphones, etc. Examples of display/playback devices include PCs (desktop/notebook/tablet), DTVs, and image display device such as digital photo frames and car navigation systems, as well as image storage devices such as picture storages and home servers, and image printing devices such as printers.

Furthermore, applicable items also include AI systems that utilize a significant amount of image data held in these and are being increasingly introduced into various fields and applications.

As application software mentioned above, the applicable items are the software providing functions for editing, displaying, printing and recording metadata as well as importing and editing images.

Specifically considered is application software that edits Exif/DCF tags and then saves them again or application software that adds metadata information undefined in the Exif Standard in Exif/DCF files and then saves it again.

2. Definitions

2.1. Definition of Terms

DSC	Digital still camera
DVC	Digital video camera
DTV	Digital television
Primary image	The main image data
Thumbnail	A small image used to index the primary image
Compressed data	Data referred to in the JPEG Standard[7] as “entropy coded data”
Tag	A field recording ancillary data about an image. Corresponds to “field” in TIFF
Tag information	A description of the tag contents
Exif	An abbreviation of “Exchange image file format,” used here as the general term for this standard and earlier versions of this standard
DCF	An abbreviation of “Design rule for Camera File System”; it defines folder structures based on Exif-JPEG and formats for recording in memory, and is the camera file system standard that guarantees interoperability among devices of different types.
DCF media	Removable memory recorded in compliance with the DCF or, removable and non-removable memory that a file system can access from an external device through IF (regardless of wired or wireless)

Exif/DCF Writer	A digital still camera (DSC) or other device or application software that can output an Exif/DCF file
Exif/DCF Editor	A device or application that edits (i.e., makes partial additions, changes, deletions) existing Exif/DCF files (Alternatively, image-editing application; includes some DTV, photo frames, and DSC)
Exif/DCF Reader	A device, such as a printer with a memory card slot, capable of directly reading an Exif/DCF file and printing or performing other output processing, as well as application software that uses Exif tags to perform image processing for output. (with playback function in conformity with the DCF Reader 1 and Reader 2 specifications described in 2.1 “Definition of Terms” of the DCF Standard)
JUMBF	An abbreviation of JPEG Universal Metadata Box Format; an ISO/IEC standard that provides a mechanism for incorporating common metadata into a JPEG file and making reference to the data. The JPEG XT file format[9] is used to incorporate a JUMBF structure into a JPEG image[7].
XML	An abbreviation of Extensible Markup Language. XML specifications are developed and recommended by the World Wide Web Consortium (W3C).
JSON	An abbreviation of JavaScript Object Notation; a data description language derived from the object notation in JavaScript.
JSON-LD	An abbreviation of JSON for Linked Data; a description format for describing data linked by networks such as websites in JSON.

The following definitions also apply to this standard:

- “.H” appended to a numerical value means it is hexadecimal notation.
- Unless otherwise indicated, other numerical values are given in decimal notation.

2.2. Verbal forms for the expression of provisions

The keywords in this document are to be interpreted as described in ISO/IEC Directives 2.

(See Directives2[26] Annex H "Verbal forms for the expression of provisions".)

Requirement

Verbal forms	Equivalent expressions
shall	is mandatory
shall not	it is not allowed

Recommendation

Verbal forms	Equivalent expressions
should	it is recommended that is recommended
should not	

Permission

Verbal forms	Equivalent expressions
may	is optional
need not	is not required

Possibility and capability

Equivalent expressions	Equivalent expressions
can	it is possible to
can not	

3. General

3.1. Format Structure

This standard consists of the Exif image file specification and the Exif audio file specification (see Figure 1). The recording medium specification shall conform to the standard for the particular medium used and is not specified here. Recommendations on implementation are given in Design rule for Camera File system[2] for directory and file naming.

<table>
<tr><th>Exif image file specification</th><th>Exif audio file specification</th></tr>
<tr><td colspan="2">Recording medium specification</td></tr>
</table>

Figure 1 Format structure

3.2. Exif Image File Specification

The Exif image file specification stipulates the method of recording image data in files, and specifies the following items:

- Structure of image data files,
- Tags used by this standard,
- Definition and management of format versions.

Features of the Exif image file specification include the following.

The file-recording format is based on existing formats. Compressed files are recorded as JPEG (ISO/IEC 10918-1[7]) with application marker segments (APP1, and APP2 or APP11 if needed) inserted. Uncompressed files are recorded in TIFF Rev. 6.0 format[17]. The use of existing formats means files recorded using a DSC or related system can be read directly by commercial applications, and makes possible the use of functions for viewing and manipulating the images.

Related attribute information for both compressed and uncompressed files is stored in the tag information format defined in TIFF Rev. 6.0[17]. Information specific to the camera system and not defined in TIFF is stored in private tags registered for Exif. The Exif image file specification also specifies the method for recording thumbnails. The reason for using the TIFF Rev. 6.0[17] tag format in the compressed file APP1 marker segment is to facilitate exchange of attribute data between Exif compressed and uncompressed files.

Compressed files can record extended data exceeding 64 KBytes by dividing it into multiple APP2 marker segments. The APP2 marker segment is used for recording Flashpix[18] extensions, or recording an Original Preservation Image (see Annex K).

In addition, the Exif image file specification specifies the data structure and recording method for describing annotation data as other attribute information for compressed files. For recording annotation data, APP11 is used.

Details of the Exif image file specification are given in Chapter 4 of this document.

3.3. Exif Audio File Specification

The Exif audio file specification stipulates the method of writing audio data in files, and specifies the following items:

- Structure of audio data files,
- Chunks,
- Definition and management of format versions.

Features of the Exif audio file specification include the following.

Files are recorded using the existing RIFF WAVE Form Audio File format[19]. As data formats, PCM and μ-Law PCM (conforming to ITU-T G.711)[15] are used for uncompressed audio data, and IMA-ADPCM[25] for compressed audio data. As with the image files specification, the aim is to enable direct reading, playback and manipulation of the files using the functions in commercial applications.

Related attribute information is stored as an INFO list in the case of general attributes, and as Exif-specific chunks in the case of attributes specific to Exif. The Exif-specific chunks are newly provided to enable necessary information to be added by making use of chunk extensibility. The recording of data in an Exif-specific chunk is done in the same way as for an INFO list.

Details of the Exif audio file specification are given in Chapter 5 of this document.

3.4. Relation between Image and Audio File Specification

This standard includes specifications not only for an image file format but also for an audio file format enabling the recording of audio as a supplementary function.

Also specified in this standard is the relational information indicating the relation between image files and audio files.

Mapping between image files and audio files can be done in various ways; but the Exif standard specifies only the simplest mapping, with others left up to the implementation.

3.5. Presupposed Systems and Compatibility

The image systems presupposed by this standard consist of three elements as follows:

・Equipment	: Imaging devices such as cameras, printers and filing equipment,
・Commercial software	: Off-the-shelf image processing software running on personal computers,
・Specialized software	: Dedicated (system-specific) image processing software running on personal computers.

Image file compatibility on these systems is achieved as follows. The DSC or other system writes data to files in the format specified in this standard. A basic condition of equipment with a playback function is that it shall read the files it recorded itself. In a personal computer environment, the basic requirement is that specialized software shall read all the images, audio and attribute information recorded in conformance with this standard (see Figure 2).

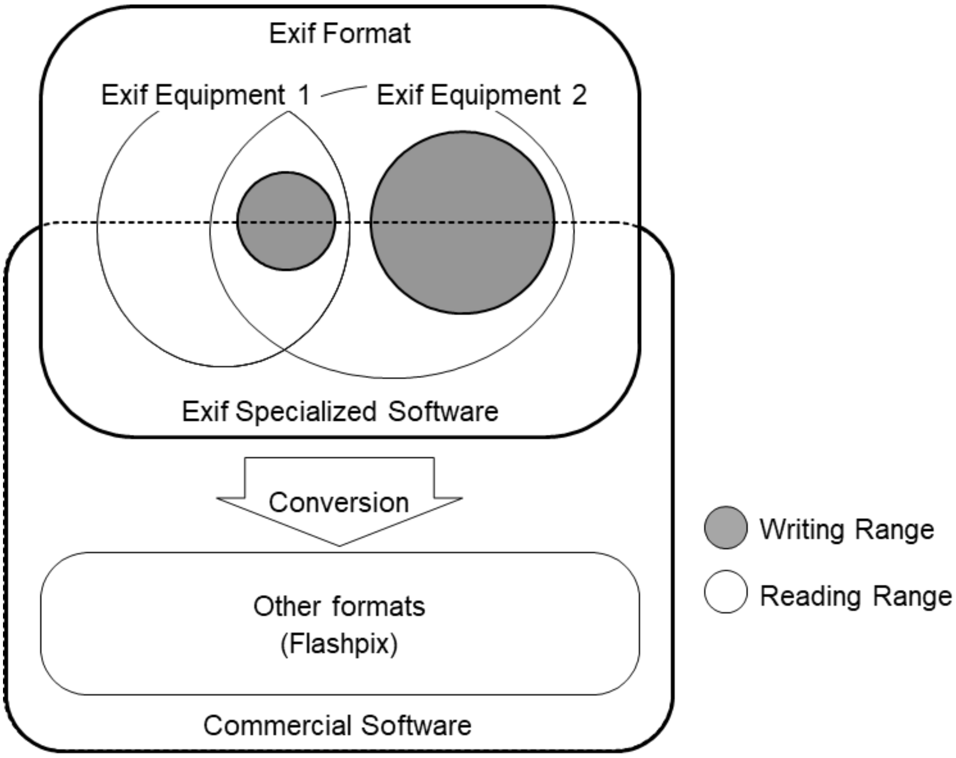


Figure 2 Compatibility Concepts

3.6. Workflow for editing an image with application software

Figure 3 shows the workflow when an Exif/DCF file is edited using an application. DSCs in this figure are examples of image capture/playback devices. Consideration is also given to the use of other devices such as a TV or printer.

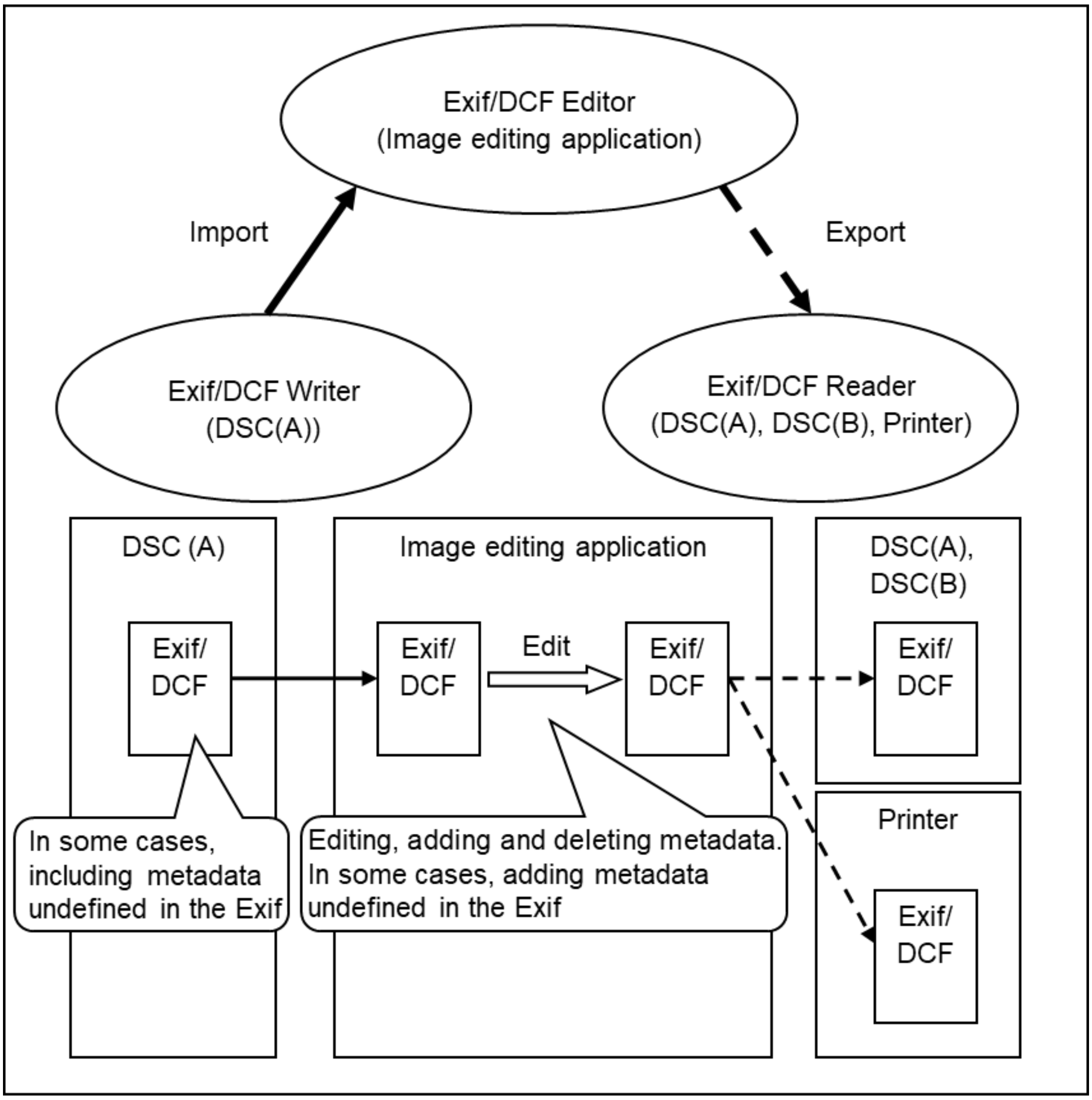

Exif/DCF Editor
(Image editing application)
Import
Export
Exif/DCF Writer
(DSC(A))
Exif/DCF Reader
(DSC(A), DSC(B), Printer)
DSC (A)
Image editing application
DSC(A),
DSC(B)
Exif/
DCF
Edit
Exif/
DCF
Exif/
DCF
Exif/
DCF
Printer
Exif/
DCF
In some cases, including metadata undefined in the Exif
Editing, adding and deleting metadata. In some cases, adding metadata undefined in the Exif

Figure 3 Editing images with application software

3.6.1. Actions

In this workflow, the following cases are considered:

1. Recording an image use an Exif/DCF writer (in some cases, recording metadata is undefined in the Exif).
2. Importing the image into an Exif/DCF editor and editing it (in some cases, adding metadata that is undefined in the Exif at this time).
3. Exporting the image that was edited in the above-mentioned Exif/DCF editor to an Exif/DCF reader. At this time, there are cases in which the Exif/DCF reader can correspond to 6. “Reader Specifications” in the DCF Specification[2], and cases when it can not.
4. Viewing the image with an Exif/DCF reader.

4. Exif Image File Specification

4.1. Outline of the Exif Image File Specification

This chapter gives details of the image file specification, covering the following items:

- Format version definition,
- Specifications relating to image data,
- Basic structure of image data,
- Tags,
- JPEG marker segments,
- Specifications on data recording.

4.2. Format Version

The version of the format specified here is recorded as 4 Bytes (see section 4.6.6.1.1). The address bytes are recorded as A1, A2, B1, and B2, starting with the lowest number. A1 and A2 store the upper part of the standard version, with the lower part stored in B1 and B2. When changes are made to the version number of this standard, the following rules apply.

- When the changes are such that data readers can properly recognize conventional information and skip the data that was recorded using newly added functions, the lower part of the version (B1, B2) is changed.
- When there is a possibility that a data reader implementing the old standard may operate incorrectly due to the new specifications, the upper part of the version (A1, A2) is changed.

Players should be able to play back files of versions earlier than the supported standard.

4.3. Definition of Glossary

Terms and notation are used as follows in this standard:

- The initial IFD in a file is the "0th IFD," with the next IFD being called the 1st IFD.

4.4. Specifications Relating to Image Data

4.4.1. Number of Pixels

There is no limit on number of pixels of the primary image when it is recorded as either uncompressed or JPEG compressed data. Note that when recording as JPEG compressed data images for which the number of lines (ImageLength) or number of samples/line (ImageWidth) is not a multiple of 8 or 16, the method of recording is as stipulated in section 4.8.1. The above specification applies similarly to thumbnails.

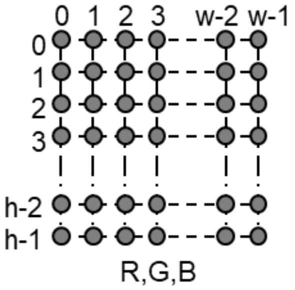
4.4.2. Pixel Aspect

Image data shall be recorded as square pixels with a pixel aspect ratio of 1:1. This specification is applied similarly to thumbnails.

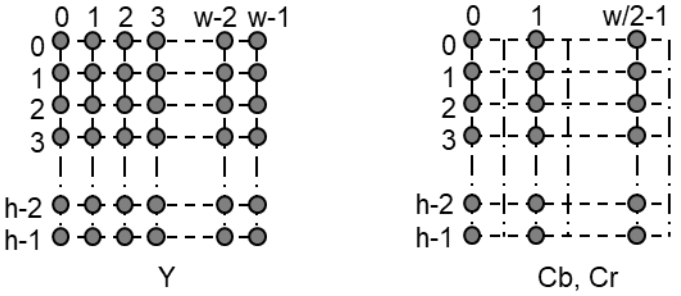
4.4.3. Pixel Composition and Sampling

When uncompressed data is used, the combination of pixel composition and pixel sampling for image data shall be RGB 4:4:4 and either Y:Cb:Cr = 4:2:2 or Y:Cb:Cr = 4:2:0. When compressed data is used, the combination shall be Y:Cb:Cr = 4:2:2 or Y:Cb:Cr = 4:2:0. The pixel composition of image data shall also be 8 bits each. This specification is applied similarly to thumbnails.

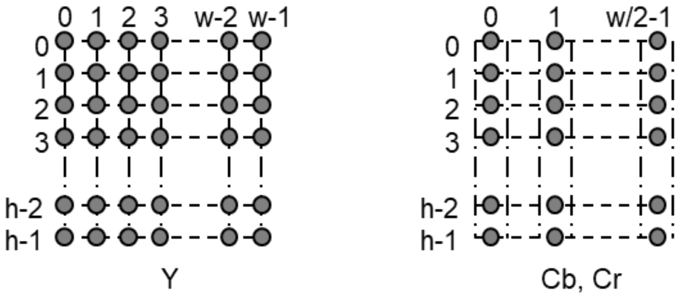
As sampling points on the elements making up pixels, the Y and Cb, Cr sampling points may be either co-sited or centered. Figure 4 shows typical pixel sampling for image width w and height h. In the case of Y:Cb:Cr = 4:2:2, co-sited is recommended for the sake of improved image quality on TV systems. For Y:Cb:Cr = 4:2:0, centered is recommended according to the TIFF default which is most common format of the personal computer applications.



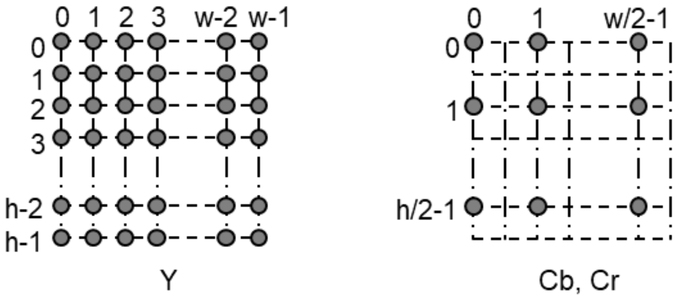
1) RGB 4:4:4



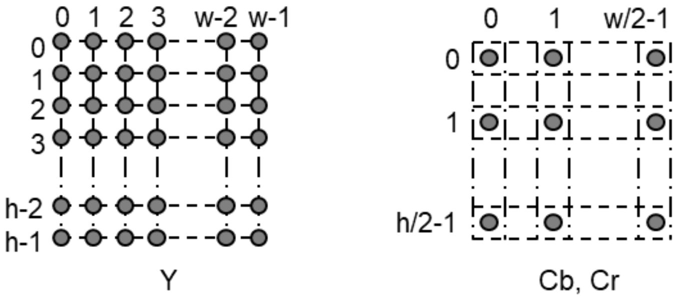
2) YCbCr 4:2:2 (co-sited)



3) YCbCr 4:2:2 (centered)



4) YCbCr 4:2:0 (co-sited)

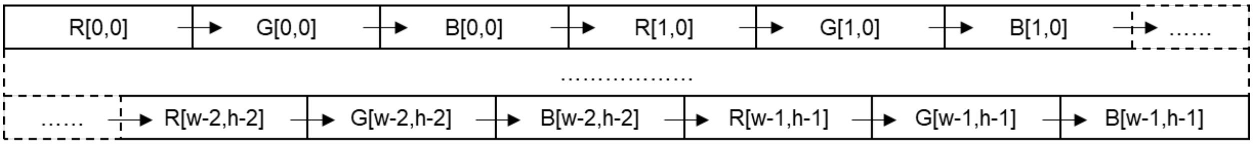


5) YCbCr 4:2:0 (centered)

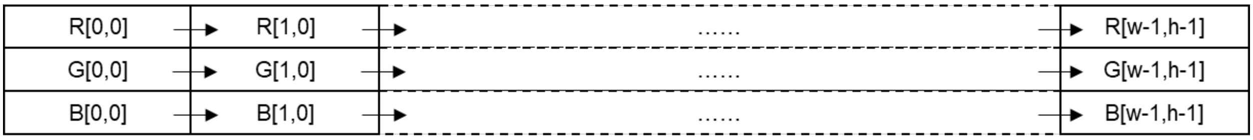
Figure 4 Pixel Composition and Pixel Sampling

4.4.4. Image Data Arrangement

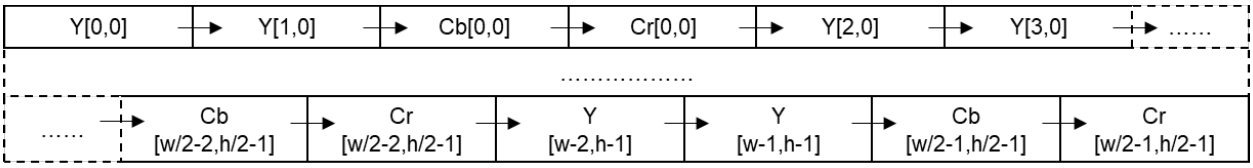
Image data shall be arranged as follows. Uncompressed data shall consist of pixels with each line traced from left to right, and one screen shall consist of lines traced from top to bottom. JPEG compressed data shall consist of blocks configured of pixels traced in similar sequence. Figure 5 shows the various data arrangements for recording in files images with pixels of width w and height h.



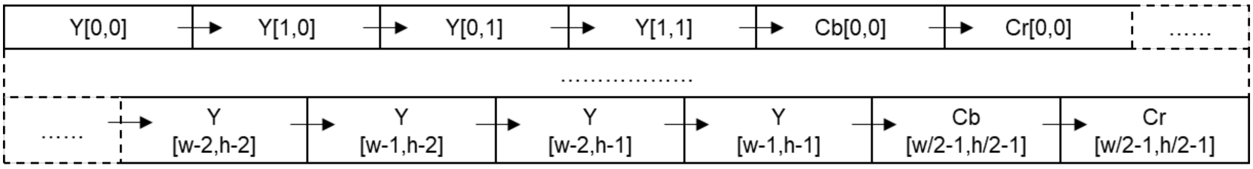
1) Uncompressed RGB Chunky (4:4:4)



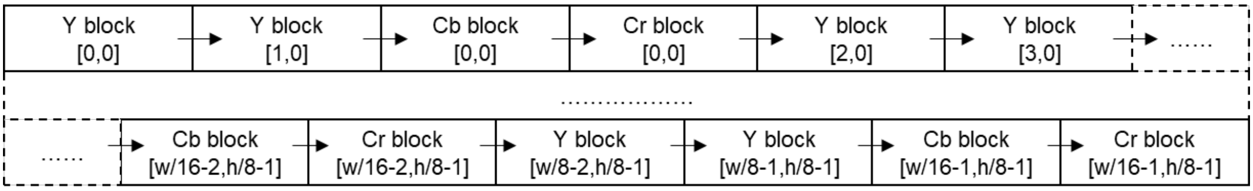
2) Uncompressed RGB Planar (4:4:4)



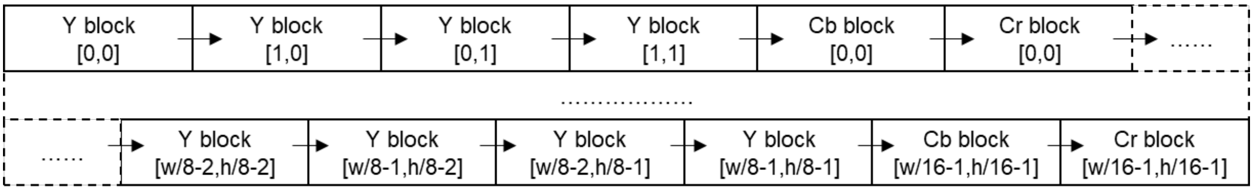
3) Uncompressed YCbCr Chunky (4:2:2)



4) Uncompressed YCbCr Chunky (4:2:0)



5) Compressed JPEG Block-Interleave (4:2:2)



6) Compressed JPEG Block-Interleave (4:2:0)

Figure 5 Data Arrangement

4.5. Basic Structure of Image Data

4.5.1. Basic Structure of Primary Image Data

Image data employs following existing image formats, depending on the image data type:

・RGB uncompressed data	: Baseline TIFF Rev. 6.0 RGB Full Color Images[17],
・YCbCr uncompressed data	: TIFF Rev. 6.0 Extensions YCbCr Images[17],
・JPEG compressed data	: JPEG Baseline ADCT[7].

For compressed data, the attribute information required by the DSC application shall be recorded in APP1. Data writing in APP1 shall be compatible with TIFF[17]. The use of a common method of storing attribute information for both compressed and uncompressed data results in a simpler format, while the ability to add private tags for additional information takes advantage of the extensibility of the tag mechanism.

4.5.2. Basic Structure of Uncompressed RGB Data

Uncompressed RGB data is recorded in conformance with Baseline TIFF Rev. 6.0 RGB Full Color Color Images[17].

Attribute information is recorded in tags specified in TIFF Rev. 6.0[17]. Attribute information specific to Exif is recorded using private tags reserved in TIFF for this standard. The private tags point to sets of this attribute information (Exif IFD).

Files are structured as follows (see Figure 6). As in the TIFF standard[17], the recording location of each IFD value is not specified:

- File Header,
- 0th IFD,
- 0th IFD Value,
- 1st IFD,
- 1st IFD Value,
- 1st (Thumbnail) Image Data,
- 0th (Primary) Image Data.

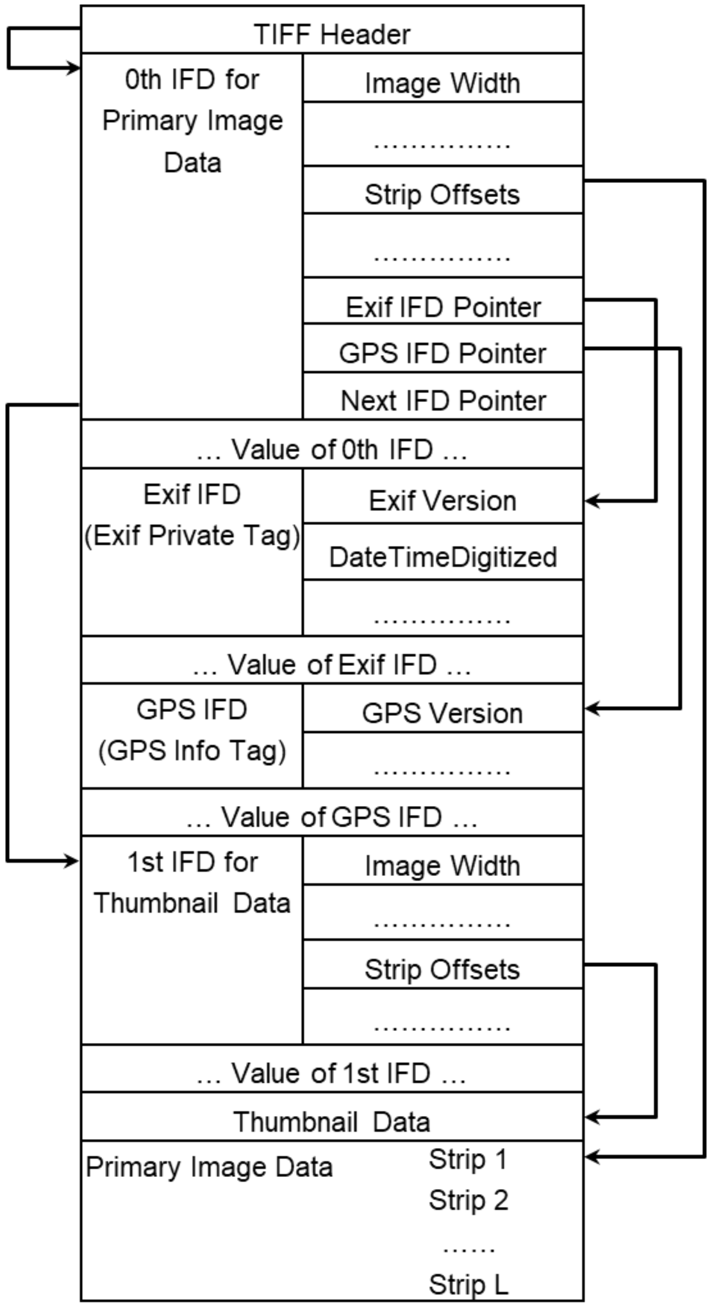


Figure 6 Basic Structure of Uncompressed Data Files

File Headers are 8 Bytes as defined in the TIFF standard[17], with the Offset of IFD indicating the start address of the 0th IFD (see Table 1).

The 0th IFD Offset of Next IFD indicates the start address of the 1st IFD (thumbnail images). When the 1st IFD is not recorded, the 0th IFD Offset of Next IFD shall terminate with 00000000.H.

On the IFD description method see section 4.6.2.

Table 1 TIFF Headers

Name	Size (Bytes)	Value
Byte Order	2	Either "II" (4949.H) (little endian) or "MM" (4D4D.H) (big endian) depending on the CPU of the machine doing the recording shall be written.
42	2	002A.H (fixed)
Offset of IFD	4	0th IFD offset. If the TIFF header is followed immediately by the 0th IFD, it is written as 00000008.H.

4.5.3. Basic Structure of YCbCr Uncompressed Data

YCbCr uncompressed data is recorded in conformance with TIFF Rev. 6.0 Extensions YcbCr Images. Tags for the following information are available for YCbCr uncompressed data in addition to the attribute information for RGB uncompressed data;

- RGB-YCbCr color transformation matrix coefficients (YCbCrCoefficients),
- Chrominance subsampling information (YCbCrSubSampling),
- Information on matching/nonmatching of chrominance and luminance samples (YCbCrPositioning).

The method of recording other attribute information is the same as for uncompressed RGB data (see section 4.5.2).

4.5.4. Basic Structure of JPEG Compressed Data

Compressed data files shall be recorded in conformance with the JPEG DCT format specified in ISO/IEC 10918-1, with the Application Market Segment (APP1, and APP2 or APP11 if needed) inserted. APP1 shall be recorded immediately after the SOI marker indicating the beginning of the file (see Figure 7). Multiple APP2 may be recorded as necessary, starting immediately after APP1. APP11 may be recorded as necessary, starting after APP1 and APP2. APPn other than APP1, APP2, and APP11, or COM marker are not used by Exif. However Exif/DCF readers should be designed skip over unknown APPn and COM.

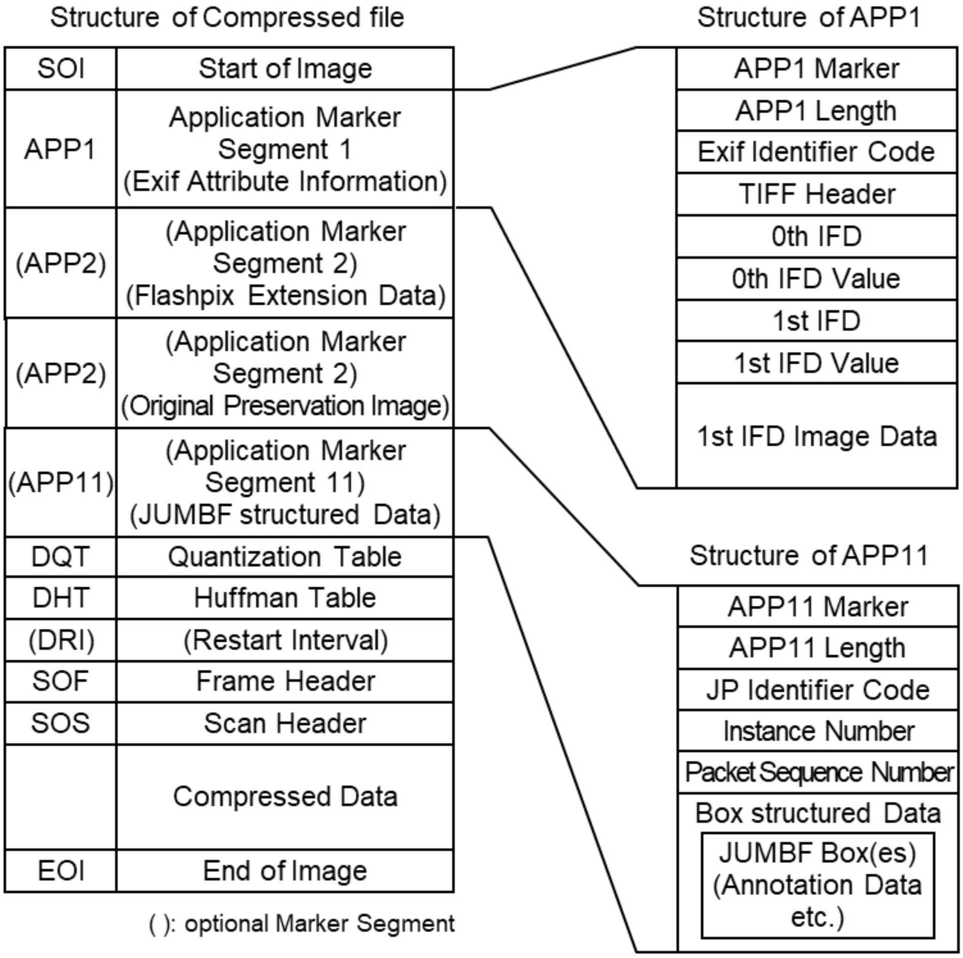


Figure 7 Basic Structure of Compressed Data Files

APP1 consists of the APP1 marker, Exif identifier code, and the attribute information itself. The size of APP1 including all these elements shall not exceed the 64 KBytes specified in the JPEG standard[7].

Attribute information is stored in TIFF structure including a File Header, with a maximum of two IFD (0th IFD, 1st IFD). The 0th IFD may record attribute information concerning the compressed image (primary image). The 1st IFD may be used to record a thumbnail image. For details see section 4.7.2

The two APP2s each contain one of the following two elements, depending on the application;

a) For Flashpix Extension Data: APP2 consists of the APP2 marker, FPXR (Flashpix-Ready, see Annex F) identifier code, and contents list for Flashpix extension recording, or stream data. A string of multiple APP2 marker segments shall be used to record data exceeding 64 KBytes. For details see section 4.7.3.

b) For Original Preservation Image: APP2 consists of the APP2 marker, MPF[3] identifier code, and MP Extensions. For details see section 4.7.4.

APP11 consists of the APP11 marker, the JPEG box format identifier code[9], the box instance number, the sequence number indicating the marker merging order, and the JUMBF box data[10].

The box instance number is used to distinguish between multiple boxes of the same type with different data contents when existent.

The data sequence number indicates the merging order when merging multiple marker segments in a case in which logically identical box data exceeds 64 KBytes, the marker size limit of JPEG standard[7], and the data is divided into multiple marker segments.

For details see section 4.7.5.

4.5.5. Application marker segments

The basic structure of JPEG compressed data in Exif adopts a configuration based on marker segments compliant with the “Baseline DCT format of JPEG” [7].

In the JPEG standard[7] on which the Exif standard is based, the use of the APPn (Reserved for application marker segments) and COM (Comment) marker segment is not restricted. In the Exif standard (See section 4.5.4), it is written, "APPn other than APP1, APP2 and APP11, or COM marker segment are not used". However, there is no mention of prohibited use of undefined APPn marker segments. Therefore, undefined APPn marker segments can be optionally used for recording by vendors or trade groups. In this case, compliance with the following rules is recommended in order to maintain reproduction compatibility with the Exif devices.In this guideline, marker segments of JPEG compressed data should be recorded in accordance with the order shown in Table 2 and should be interpreted as described in the table.

That is, it is possible to optionally record multiple APPn (n is a value from zero to 15) marker segments immediately after APP1, APP2 and APP11 defined in the Exif standard.

The bracketed marker segment names in Figure 7, Figure 8 and Table 2 show optional marker segments in the Exif standard.

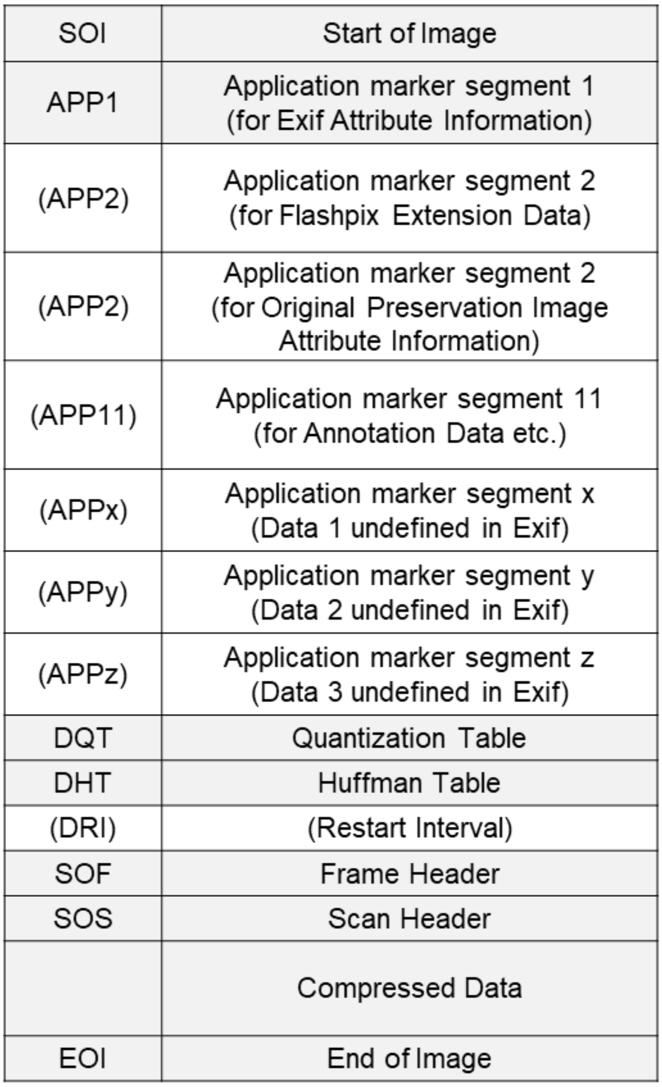
Table 2 Marker segments of JPEG compressed data in Exif

No	Name of marker	Specification in the Exif standard
1	SOI	Recording this marker is mandatory. It shall be recorded in this position at the beginning of all markers.
2	APP1	Exif Attribute Information Recording this marker is mandatory. It shall be recorded in this position immediately after SOI.
3	(APP2)	Flashpix Extension data Recording this marker is optional. Multiple APP2 markers for the data can be optionally recorded . It shall be recorded in this position, if necessary.
4	(APP2)	Attribute Information for Original Preservation Image Recording this marker is optional. Any number of APP2 markers for the Attribute Information can be recorded. They shall be recorded in this position, if necessary.

5	(APP11)	JUMBF Box-structured data containing Annotation Data etc. Recording this marker is optional. Any number of APP11 markers can be optionally recorded. They shall be recorded in the position after APP1 and APP2, if necessary.
6	(APPn)	Recording this marker is optional. Multiple markers can be recorded, as necessary (including APP1, APP2 and APP11 other than those listed above in this table).
7	DQT, DHT, (DRI), SOF	Other marker groups defined in Exif Only the DRI marker is optional. Recording the rest of the markers is mandatory. Their recording order may be changeable.
8	SOS (compressed data)	If the DRI marker is recorded, the RSTm marker shall be inserted as well.
9	EOI	Recording this marker is mandatory. It shall be recorded in this position.

The following Figure 8 shows an example structure of JPEG compressed data when undefined data in the Exif standard is added. The marker segments with filled background in the figure are mandatory in this specification.

In this case, the added marker segments are assumed as APPx, APPy and APPz (x, y and z are optional numbers from zero to 15).



SOI	Start of Image
APP1	Application marker segment 1 (for Exif Attribute Information)
(APP2)	Application marker segment 2 (for Flashpix Extension Data)
(APP2)	Application marker segment 2 (for Original Preservation Image Attribute Information)
(APP11)	Application marker segment 11 (for Annotation Data etc.)
(APPx)	Application marker segment x (Data 1 undefined in Exif)
(APPy)	Application marker segment y (Data 2 undefined in Exif)
(APPz)	Application marker segment z (Data 3 undefined in Exif)
DQT	Quantization Table
DHT	Huffman Table
(DRI)	(Restart Interval)
SOF	Frame Header
SOS	Scan Header
	Compressed Data
EOI	End of Image

Figure 8 Structure of JPEG compressed data with added APPn in Exif (Example)

4.5.6. How to deal with APPn markers undefined in the Exif standard

Exif/DCF writers should record only the minimum for vendors when recording APPn markers undefined in the Exif standard. Especially, metadata for which the content is inconsistent with that of metadata written in the Exif standard should not be recorded.

Even if APPn markers are undefined in the Exif standard and incomprehensible, Exif/DCF editors should not delete them, in consideration that the necessary information is recorded. Moreover, Exif/DCF editors should add only the minimum for vendors when adding APPn markers undefined in the Exif standard. Especially, metadata for which the content is inconsistent with that of metadata written in the Exif standard should not be added. APPn markers undefined in the Exif standard should be recorded in ascending order of the marker code.

When adding APPn markers, because the volume becomes quite large, current devices might not be able to handle the file itself. In other cases, the large volume might affect the performance of the device. Such cases should be kept in mind. For example, when an Exif/DCF editor uses optional APPn to add unique information to the file created by an Exif/DCF writer, the file size increases by the amount of added information. Even if the additional information is small, because the file size increases, some Exif/DCF readers might not properly handle the file itself due to the regulation in the specifications of the device. Other Exif/DCF readers might be affected in terms of performance. Therefore, it is necessary to take into account such cases.

Exif/DCF readers should be implemented to operate without interruption even if APPn markers undefined in the Exif standard have been recorded. It is recommended that Exif/DCF readers be designed to skip over unknown APP markers in the Exif standard (see section 4.5.4).

4.5.7. Recording data other than the primary image

The JPEG standard[7] defines data formats such as compressed image data format and it does not mention file formats. Therefore, it is possible to add information other than the primary image by separately defining the structure of an image file.

For example, the file formats for recording multiple images and for information other than images are considered. If there is a standard specification, specific methods for implementation and handling should comply with the standard specification.

In Exif/DCF editors, when APP markers compliant with a standard specification are used to manage the start address of an image with offset in files, it should be considered that the start address of the image might be changed by adding the APPn markers.

In Exif/DCF writers, when data is recorded using a unique method that does not comply with a standard specification, it should be kept in mind that the data might be changed or deleted when used with other Exif/DCF writers or editors.

Moreover, Exif/DCF readers should be implemented to operate without interruption even if certain kinds of data have been recorded after EOI of the primary image defined in the Exif standard. Specifically, unknown data after EOI of the primary image should be skipped. (see section 4.7.1)

4.5.8. Basic Structure of Thumbnail Data

Thumbnail data is recorded in the 1st IFD similarly to primary images, using two existing image formats.

No limit is placed on the size of thumbnail images. It is optional to record thumbnails but it is recommended that they be recorded if possible, unless hardware or other restrictions preclude this.Thumbnail data does not necessarily have to adopt the same data structure as that used for primary images. If, however, the primary images are recorded as uncompressed RGB data or as uncompressed YCbCr data, thumbnail images shall not be recorded as JPEG compressed data (see Table 3).

Table 3 Combinations of primary image and thumbnail data structures

		Primary Image	
		Uncompressed	**Compressed**
Thumbnail	**Uncompressed**	Possible	Possible
	Compressed	Not possible	Possible

When thumbnails are recorded in uncompressed format, they are to be recorded in the 1st IFD in conformance with Baseline TIFF Rev. 6.0 RGB Full Color Images[17] or TIFF Rev. 6.0 Extensions YCbCr Images[17].

An Exif-specific recording method is used to record compressed thumbnails.

In this case the Compression tag value is set to ‘6’ and tags in the 1st IFD (JPEG Interchange Format, JPEG Interchange Format Length) are used to designate the location and size. The images are recorded at the designated location as a JPEG stream (from SOI to EOI) conforming to the JPEG Baseline DCT format[7]. APPn marker, COM marker, nor restart marker shall not be recorded in the JPEG stream (see Figure 9). To avoid duplicate definitions, the 1st IFD is not used to record a tag indicating a TIFF image or information recorded elsewhere as a JPEG marker segment.

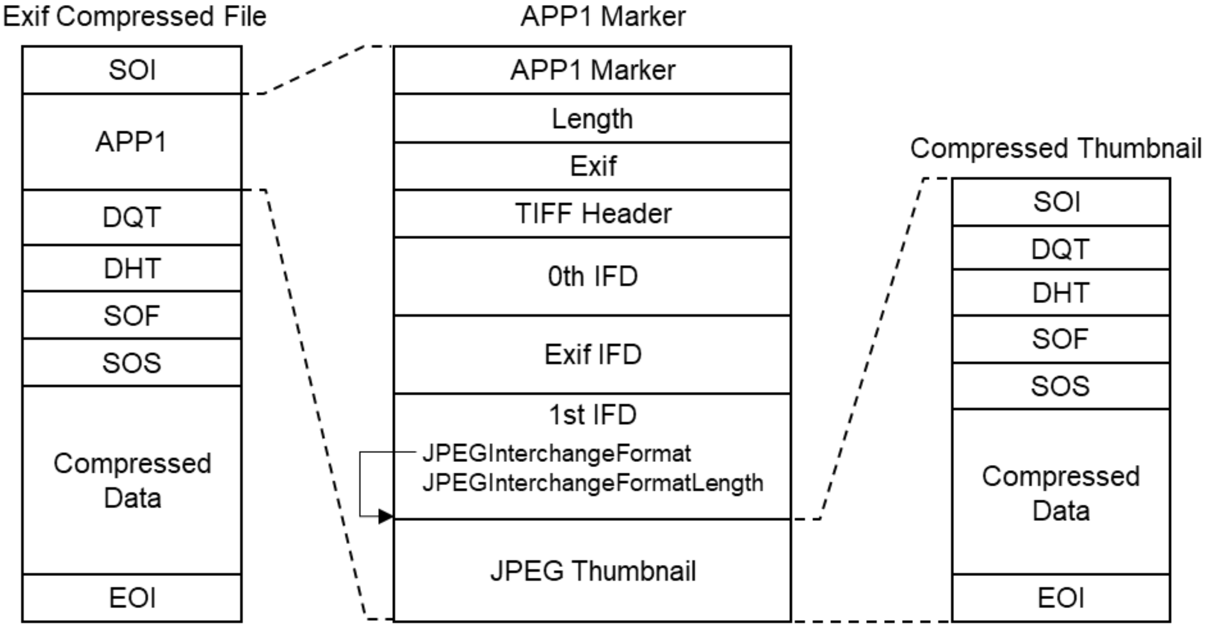


Figure 9 Structure of Exif file with compressed thumbnail

4.6. Tags

4.6.1. Features of Attribute Information

RGB data conforms to Baseline TIFF Rev. 6.0 RGB Full Color Images[17] and YCbCr data to TIFF Rev. 6.0 Extensions YCbCr Images[17]. Accordingly, the parts that follow the TIFF structure shall be recorded in conformance to the TIFF standard. In addition to the attribute information indicated as mandatory in the TIFF standard, this Exif standard adds the TIFF optional tags that can be used in a DSC or other system, Exif-specific tags for recording DSC-specific attribute information, and GPS tags for recording position information. There are also Exif-original specifications not found in the TIFF standard[17] for compressed recording of thumbnails.

Recording of compressed data differs from uncompressed data in the following respects:

- When the primary image data is recorded in compressed form, there is no tag indicating the primary image itself or its address (pointer),
- When thumbnail data is recorded in compressed form, address and size are designated using Exif-specific tags,
- Tags that duplicate information given in the JPEG Baseline[7] are not recorded (for either primary images or thumbnails).
- Information relating to compression can be recorded using the tags for this purpose.

4.6.2. IFD Structure

The IFD used in this standard consists of a 2-byte count (number of fields), 12-byte field entry arrays, and 4-byte offset to the next IFD, in conformance with TIFF Rev. 6.0[17]. Each of the 12-byte field entry consists of the following four elements respectively.

Bytes 0-1	Tag
Bytes 2-3	Type
Bytes 4-7	Count
Bytes 8-11	Value Offset

Each element is explained briefly below. For details see TIFF Rev. 6.0[17].

Tag

Each tag is assigned a unique 2-byte number to identify the field. The tag numbers in the Exif 0th IFD and 1st IFD are all the same as the TIFF tag numbers.

Type

The following types are used in Exif:

1 = BYTE	An 8-bit unsigned integer.
2 = ASCII	An 8-bit byte containing one 7-bit ASCII code. The final byte is terminated with NULL[00.H]. The ASCII count shall include NULL.
3 = SHORT	A 16-bit (2-byte) unsigned integer,
4 = LONG	A 32-bit (4-byte) unsigned integer,
5 = RATIONAL	Two LONGs. The first LONG is the numerator and the second LONG expresses the denominator.
7 = UNDEFINED	An 8-bit byte that may take any value depending on the field definition.
9 = SLONG	A 32-bit (4-byte) signed integer (2's complement notation).

10 = SRATIONAL	Two SLONGs. The first SLONG is the numerator and the second SLONG is the denominator.
129 = UTF-8	An 8-bit byte representing a string according to UTF-8[21]. The final byte is terminated with NULL[00.H]. BOM (Byte Order Mark) shall not be used. The UTF-8 count shall include NULL. This is defined independently by this standard, rather than in TIFF6.0.

Count

The number of values. It should be noted carefully that the count is not necessarily the sum of the bytes. In the case of one value of SHORT (16 bits), for example, the count is '1' even though it is 2 Bytes. In the case of UTF-8 (8 bits), for example, one value is 1 Byte, so the count is equal to the total number of bytes including NULLs, but note that this does not necessarily equal the total number of characters because the code indicating one character is of variable length.

Value Offset

This tag records the offset from the start of the TIFF header to the position where the value itself is recorded. In cases where the value fits in 4 Bytes, the value itself is recorded. If the value is smaller than 4 Bytes, the value is stored in the 4-byte area starting from the left, i.e., from the lower end of the byte offset area. For example, in big endian format, if the type is SHORT and the value is 1, it is recorded as 00010000.H.

Note that field entry shall be recorded in sequence starting from the smallest tag number.

There is no stipulation regarding the order or position of tag value (Value) recording.

4.6.3. Exif-specific IFD

4.6.3.1. Exif IFD

Exif IFD is a set of tags for recording Exif-specific attribute information. It is pointed to by the offset from the TIFF header (Value Offset) indicated by an Exif private tag value.

4.6.3.1.1. Exif IFD Pointer

Tag = 34665 (8769.H)
Type = LONG
Count = 1
Default = None

A pointer to the Exif IFD. The Exif IFD has the same structure as that of the IFD specified in TIFF. However, it does not contain image data as in the case of TIFF.

4.6.3.2. GPS IFD

GPS IFD is a set of tags for recording information such as a Global Navigation Satellite System (GNSS) including GPS and other various positioning systems or services. It is pointed to by the offset from the TIFF header (Value Offset) indicated by a GPS private tag value.

4.6.3.2.1. GPS Info IFD Pointer

Tag = 34853 (8825.H)
Type = LONG
Count = 1
Default = None

A pointer to the GPS Info IFD. The internal structure of the GPS Info IFD, like that of Exif IFD, has no image data.

4.6.3.3. Interoperability IFD

Interoperability IFD is composed of tags which store the information to ensure interoperability and pointed by the following tag located in Exif IFD.

4.6.3.3.1. Interoperability IFD Pointer

Tag = 40965 (A005.H)
Type = LONG
Count = 1
Default = None

The Interoperability IFD has the same structure as that of the IFD specified in TIFF. However, it does not contain image data as in the case of TIFF.

4.6.4. Character Identifier Code

Several UNDEFINED tags that handle character information can handle multicode by specification of the character code.

To identify the characters written in these tags, an ID code is entered in a fixed 8-byte area at the start of the tag data area. The unused portion of the ID code area shall be padded with NULL. ID codes are assigned by means of registration.

The reference for each character code is given in Table 4. The value of the Count is determined based on the 8 bytes in the character code area and the number of bytes in the actual string data area following the character code area. Note that since the TYPE is UNDEFINED, NULL termination is not necessary (see Figure 10).

Table 4 Character Codes and Character Code Designations

Character Code	Character Identifier Code (8Byte)	Base Format / Reference	
		Character Encoding	Character Set
ASCII	41.53.43.49. 49.00.00.00.H	ANSI INCITS 4[16]	
JIS	4A.49.53.00. 00.00.00.00.H	ISO-2022-JP[4]	JIS X 0208[5]
Unicode	55.4E.49.43. 4F.44.45.00.H	UTF-8[21]	Unicode[20]
Undefined Text	00.00.00.00. 00.00.00.00.H	—	—

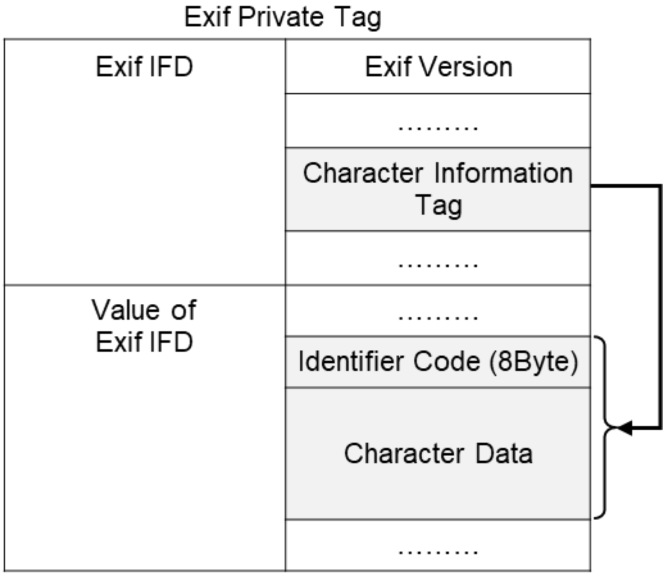


Figure 10 Configuration Example of Multicode Character Information Tag

The ID code may be a Defined code such as JIS[5]or ASCII, or may be Undefined. The Undefined name is Undefined Text, and the ID code is filled with 8 Bytes of all NULL. An Exif/DCF Reader that reads the tag shall have a function for determining the ID code. Note that this function is not required in Exif/DCF readers that do not use the multicode tag (see Table 5).

Table 5 Differences Between Defined and Undefined Character Code Implementation

ID Code	Exif/DCF Reader Implementation
Defined (JIS, ASCII, etc.)	Determines the ID code and displays the code in accord with the Exif/DCF reader capability.
Undefined (all NULL)	Depends on the localized PC environment, etc., in each country. (If a character code is used for which there is no clear specification like Shift-JIS in Japan, Undefined is used.) Although the possibility of unreadable characters exists, display of these characters is left as a matter of Exif/DCF reader implementation

When a tag is set aside for the purpose of maintaining a character information area, it is recommended that the ID code be ASCII and that the following character information be filled with blank characters [20.H].

4.6.5. TIFF Rev. 6.0 Attribute Information

Table 6 lists the attribute information used in Exif, including the attributes given as mandatory in Baseline TIFF Rev. 6.0 RGB Full Color Images and TIFF Rev. 6.0 Extensions YCbCr Images, as well as the optional TIFF tags used by DSC and other systems. The contents are explained below.

Table 6 TIFF Rev. 6.0 Attribute Information Used in Exif

Tag Name	Field Name	Tag ID		Type	Count
		Dec	Hex		
A. Tags relating to image data structure					
Image width	ImageWidth	256	100	SHORT or LONG	1
Image height	ImageLength	257	101	SHORT or LONG	1
Number of bits per component	BitsPerSample	258	102	SHORT	3
Compression scheme	Compression	259	103	SHORT	1
Pixel composition	PhotometricInterpretation	262	106	SHORT	1
Orientation of image	Orientation	274	112	SHORT	1
Number of components	SamplesPerPixel	277	115	SHORT	1
Image resolution in width direction	XResolution	282	11A	RATIONAL	1
Image resolution in height direction	YResolution	283	11B	RATIONAL	1
Image data arrangement	PlanarConfiguration	284	11C	SHORT	1
Unit of X and Y resolution	ResolutionUnit	296	128	SHORT	1
Subsampling ratio of Y to C	YCbCrSubSampling	530	212	SHORT	2
Y and C positioning	YCbCrPositioning	531	213	SHORT	1
B. Tags relating to recording offset					
Offset to strip	StripOffsets	273	111	SHORT or LONG	*S
Number of rows per strip	RowsPerStrip	278	116	SHORT or LONG	1
Bytes per compressed strip	StripByteCounts	279	117	SHORT or LONG	*S
Offset to JPEG SOI	JPEGInterchangeFormat	513	201	LONG	1
Bytes of JPEG data	JPEGInterchangeFormatLength	514	202	LONG	1
C. Tags relating to image data characteristics					
Transfer function	TransferFunction	301	12D	SHORT	3 * 256
White point chromaticity	WhitePoint	318	13E	RATIONAL	2
Chromaticities of primaries	PrimaryChromaticities	319	13F	RATIONAL	6
Color space transformation matrix coefficients	YCbCrCoefficients	529	211	RATIONAL	3
Pair of black and white reference values	ReferenceBlackWhite	532	214	RATIONAL	6

D. Other tags					
Description of Image	ImageDescription	270	10E	ASCII or UTF-8	Any
Image input equipment manufacturer	Make	271	10F	ASCII or UTF-8	Any
Image input equipment model	Model	272	110	ASCII or UTF-8	Any
Software used	Software	305	131	ASCII or UTF-8	Any
File change date and time	DateTime	306	132	ASCII	20
Person who created the image	Artist	315	13B	ASCII or UTF-8	Any
Copyright holder	Copyright	33432	8298	ASCII or UTF-8	Any

*S Chunky format : StripsPerImage
Planar format : SamplesPerImage * StripsPerImage
StripsPerImage = floor((ImageLength + RowsPerStrip -1)/ RowsPerStrip)

4.6.5.1. A. Tags relating to image data structure

4.6.5.1.1. ImageWidth

The number of columns of image data, equal to the number of pixels per row. In JPEG compressed data, this tag shall not be used because a JPEG marker is used instead of it.

Tag = 256 (100.H)
Type = SHORT or LONG
Count = 1
Default = None

4.6.5.1.2. ImageLength

The number of rows of image data. In JPEG compressed data, this tag shall not be used because a JPEG marker is used instead of it.

Tag = 257 (101.H)
Type = SHORT or LONG
Count = 1
Default = None

4.6.5.1.3. BitsPerSample

The number of bits per image component. In this standard each component of the image is 8 bits, so the value for this tag is 8. See also SamplesPerPixel. In JPEG compressed data, this tag shall not be used because a JPEG marker is used instead of it.

Tag = 258 (102.H)
Type = SHORT
Count = 3
Default = 8 8 8

4.6.5.1.4. Compression

The compression scheme used for the image data. When a primary image is JPEG compressed, this designation is not necessary. So, this tag shall not be recorded. When thumbnails use JPEG compression, this tag value is set to 6.

Tag = 259 (103.H)
Type = SHORT
Count = 1
Default = None

1 = uncompressed
6 = JPEG compression (thumbnails only)
Other = reserved

4.6.5.1.5. PhotometricInterpretation

The pixel composition. In JPEG compressed data, this tag shall not be used because a JPEG marker is used instead of it.

Tag = 262 (106.H)
Type = SHORT
Count = 1
Default = None

2 = RGB
6 = YCbCr
Other = reserved

4.6.5.1.6. Orientation

The image orientation viewed in terms of rows and columns.

Tag = 274 (112.H)
Type = SHORT
Count = 1
Default = 1

1 = The 0th row is at the visual top of the image, and the 0th column is the visual left-hand side.
2 = The 0th row is at the visual top of the image, and the 0th column is the visual right-hand side.
3 = The 0th row is at the visual bottom of the image, and the 0th column is the visual right-hand side.
4 = The 0th row is at the visual bottom of the image, and the 0th column is the visual left-hand side.
5 = The 0th row is the visual left-hand side of the image, and the 0th column is the visual top.
6 = The 0th row is the visual right-hand side of the image, and the 0th column is the visual top.
7 = The 0th row is the visual right-hand side of the image, and the 0th column is the visual bottom.
8 = The 0th row is the visual left-hand side of the image, and the 0th column is the visual bottom.

Other = reserved

Recording orientation

Table 7 shows the relationship between the total number of columns and total number of rows of coded image data that is stored in an Exif image file and an Exif tag.

Table 7 Relationship between column count/row count of coded image data and Exif tag

	When uncompressed RGB and YCbCr data (See 4.6.5.1)	When compressed JPEG data (See 4.6.6.3)
Column count	ImageWidth tag	PixelXDimension
Row count	ImageLength tag	PixelYDimension

Figure 11 shows the pixel arrangement of coded image data that is stored in an Exif image file. It should be noted that the notation "(3,2)" in the figure indicates the pixel location "third column, second row." (See section 4.4.4 for details)

	C0	C1	C2	C3
R0	(0, 0)	(1, 0)	(2, 0)	(3, 0)
R1	(0, 1)	(1, 1)	(2, 1)	(3, 1)
R2	(0, 2)	(1, 2)	(2, 2)	(3, 2)

Figure 11 Data array of an Exif image file

Figure 12 shows the orientation of an image display on a display device. The notation "visual top" refers to the upper edge of the displayed image when looking directly at the screen from its front. Likewise, the notations "visual left-hand," "visual right-hand," and "visual bottom" refer to the left edge, right edge, and bottom edge of the screen, respectively.

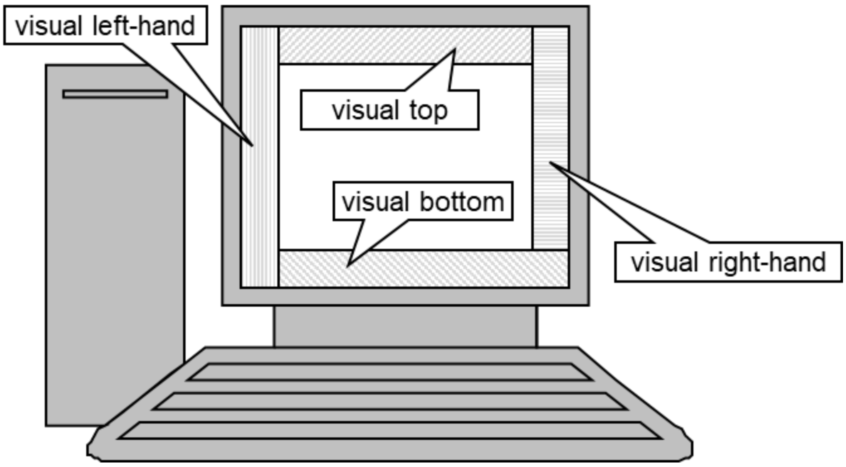
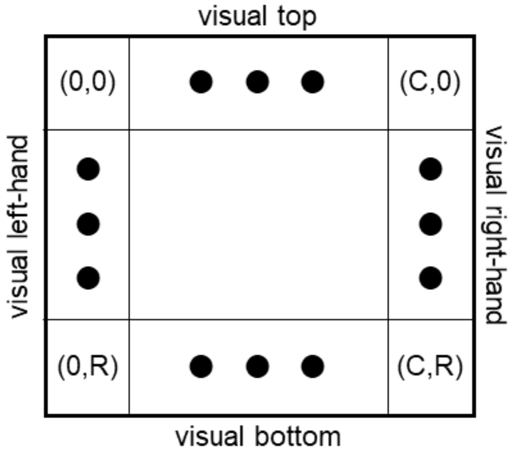


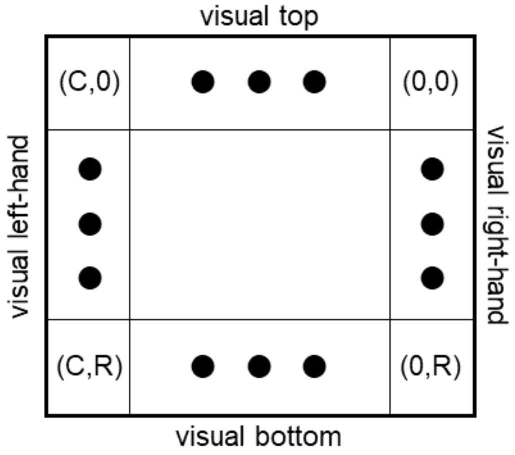
Figure 12 Orientation of an image display on a display device

Figure 13 shows the relationship between coded image data that is stored in an Exif image file and orientation of the image display on a display screen according to the orientation tag.

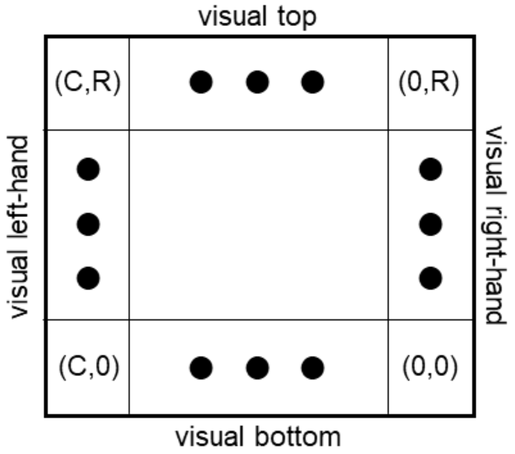
Orientation = 1



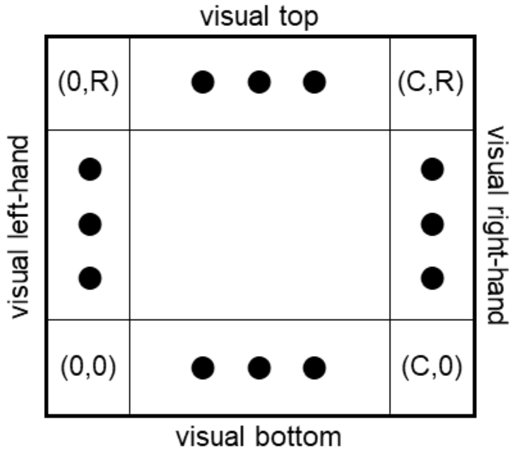
Orientation = 2



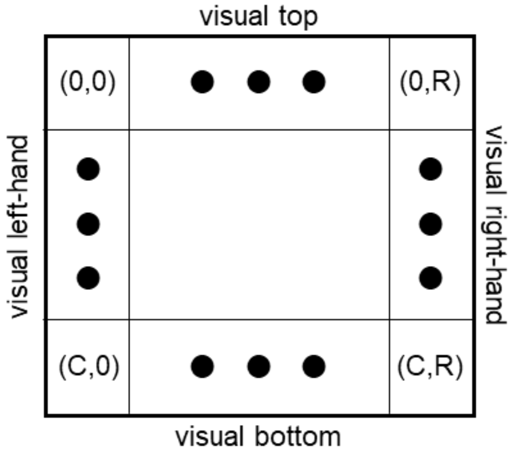
Orientation = 3



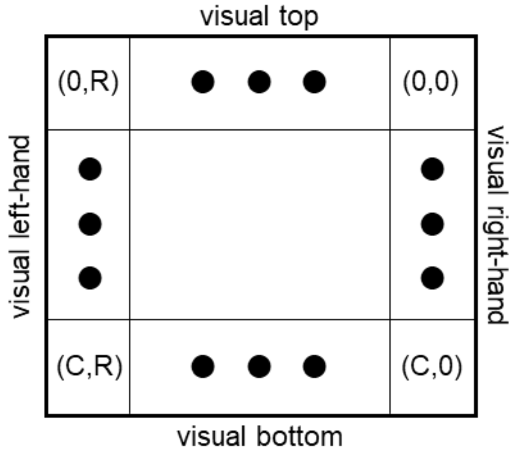
Orientation = 4

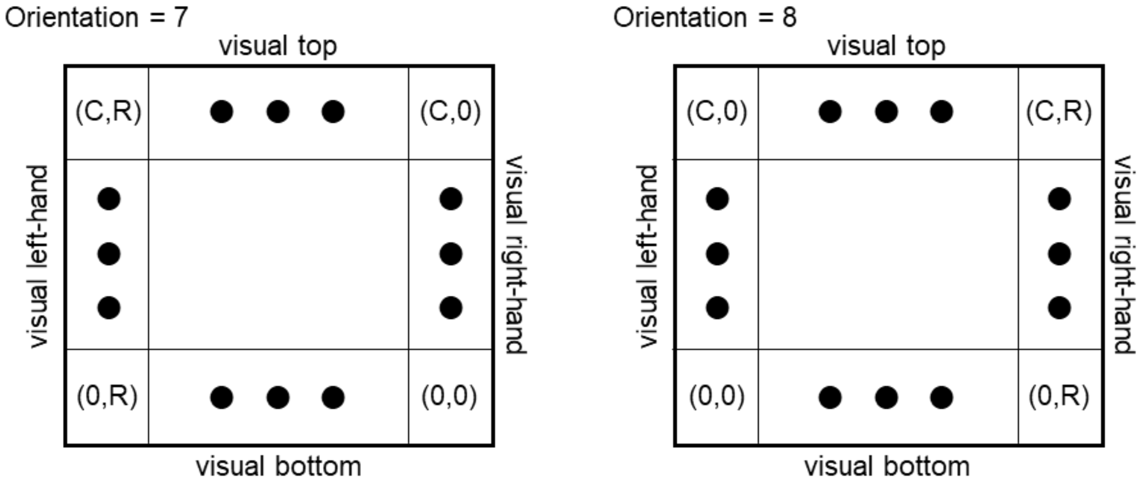


Orientation = 5



Orientation = 6





※ (0, 0) = (smallest column number, smallest row number)
(C, R) = (largest column number, largest row number)

Figure 13 Relationship between image data and orientation on a display screen according to an orientation tag

Orientation = 1 is set when 0th row of the coded image data stored in the Exif image file and the visual top of the display screen, and 0th column and visual left, will each be matched for display

Orientation = 2 is equivalent to an arrangement that is reversed Orientation = 1 : horizontally

Orientation = 3 is equivalent to an arrangement that is turned Orientation = 6 : 90 degrees clockwise

Orientation = 4 is equivalent to an arrangement that is reversed Orientation = 3 : horizontally

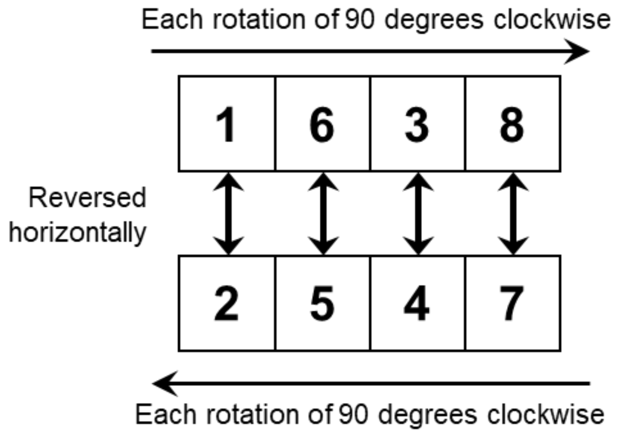
Orientation = 5 is equivalent to an arrangement that is reversed Orientation = 6 : horizontally

Orientation = 6 is equivalent to an arrangement that is turned Orientation = 1 : 90 degrees clockwise

Orientation = 7 is equivalent to an arrangement that is reversed Orientation = 8 : horizontally

Orientation = 8 is equivalent to an arrangement that is turned Orientation = 3 : 90 degrees clockwise

Figure 14 shows the relationship between the orientation tag and rotation processing that should be conducted when displaying coded image data that is stored on an Exif image file on a screen.


Each rotation of 90 degrees clockwise
1
6
3
8
Reversed horizontally
2
5
4
7
Each rotation of 90 degrees clockwise

(The integers 1 to 8 in the table are orientation tag values)

Figure 14 Relationship between the orientation tag and rotation processing to display image data on a screen

4.6.5.1.7. SamplesPerPixel

The number of components per pixel. Since this standard applies to RGB and YCbCr images, the value set for this tag is 3. In JPEG compressed data, this tag shall not be used because a JPEG marker is used instead of it.

Tag = 277 (115.H)
Type = SHORT
Count = 1
Default = 3

4.6.5.1.8. XResolution

The number of pixels per ResolutionUnit in the ImageWidth direction. When the image resolution is unknown, 72 [dpi] shall be designated.

Tag = 282 (11A.H)
Type = RATIONAL
Count = 1
Default = 72

4.6.5.1.9. YResolution

The number of pixels per ResolutionUnit in the ImageLength direction. The same value as XResolution shall be designated.

Tag = 283 (11B.H
Type = RATIONAL
Count = 1
Default = 72

4.6.5.1.10. PlanarConfiguration

Indicates whether pixel components are recorded in chunky or planar format. In JPEG compressed data, this tag shall not be used because a JPEG marker is used instead of it. If this field does not exist, the TIFF default of 1 (chunky) is assumed.

Tag = 284 (11C.H)
Type = SHORT
Count = 1
Default = None

1 = chunky format

2 = planar format

Other = reserved

4.6.5.1.11. ResolutionUnit

The unit for measuring XResolution and YResolution. The same unit is used for both XResolution and YResolution. If the image resolution in unknown, 2 (inches) shall be designated.

Tag = 296 (128.H)
Type = SHORT
Count = 1
Default = 2

2 = inches

3 = centimeters

Other = reserved

4.6.5.1.12. YCbCrSubSampling

The sampling ratio of chrominance components in relation to the luminance component. In JPEG compressed data a JPEG marker is used instead of this tag. So, this tag shall not be recorded

Tag = 530 (212.H)
Type = SHORT
Count = 2
Default = None

[2, 1] = YCbCr4:2:2

[2, 2] = YCbCr4:2:0

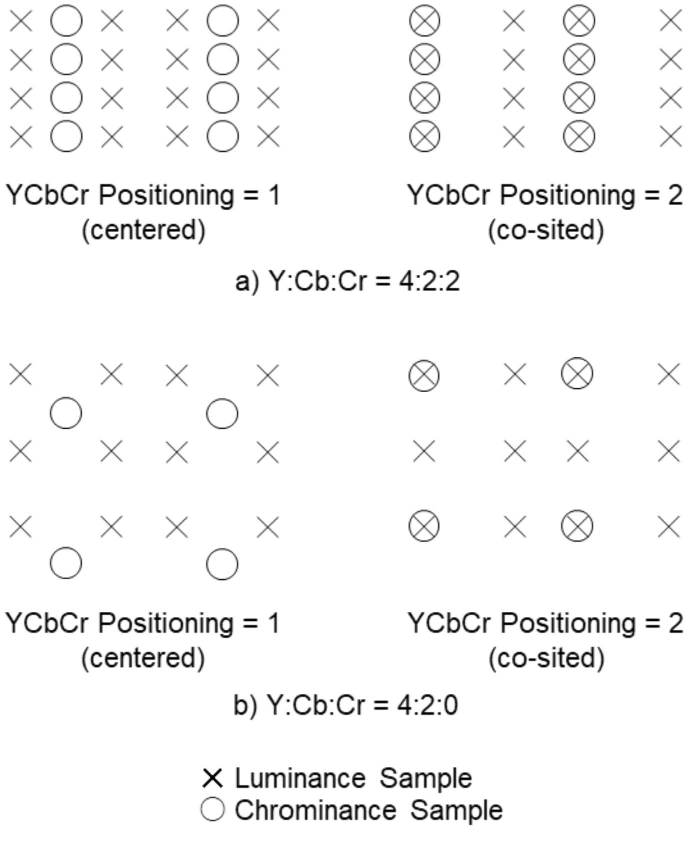
Other = reserved

4.6.5.1.13. YCbCrPositioning

The position of chrominance components in relation to the luminance component. This field is designated only for JPEG compressed data or uncompressed YCbCr data. The TIFF default is 1 (centered); but when Y:Cb:Cr = 4:2:2 it is recommended in this standard that 2 (co-sited) be used to record data, in order to improve the image quality when viewed on TV systems. When this field does not exist, the reader shall assume the TIFF default. In the case of Y:Cb:Cr = 4:2:0, the TIFF default (centered) is recommended. If the Exif/DCF reader does not have the capability of supporting both kinds of YCbCrPositioning, it shall follow the TIFF default regardless of the value in this field. It is preferable that readers can support both centered and co-sited positioning.

Tag = 531 (213.H)
Type = SHORT
Count = 1
Default = 1

1 = centered
2 = co-sited
Other = reserved



a) Y:Cb:Cr = 4:2:2

b) Y:Cb:Cr = 4:2:0

Figure 15 YcbCrPositioning

4.6.5.2. B. Tags relating to recording offset

4.6.5.2.1. StripOffsets

For each strip, the byte offset of that strip. It is recommended that this be selected so the number of strip bytes does not exceed 64 KBytes. In the case of JPEG compressed data, this designation is not necessary. So, this tag shall not be recorded. See also RowsPerStrip and StripByteCounts.

Tag = 273 (111.H)
Type = SHORT or LONG
Count = StripsPerImage (when PlanarConfiguration = 1)
= SamplesPerPixel * StripsPerImage (when PlanarConfiguration = 2)
Default = None

4.6.5.2.2. RowsPerStrip

The number of rows per strip. This is the number of rows in the image of one strip when an image is divided into strips. In the case of JPEG compressed data, this designation is not necessary. So, this tag shall not be recorded.

Tag = 278 (116.H)
Type = SHORT or LONG
Count = 1
Default = None

4.6.5.2.3. StripByteCounts

The total number of bytes in each strip. In the case of JPEG compressed data, this designation is not necessary. So, this tag shall not be recorded.

Tag = 279 (117.H)
Type = SHORT or LONG
Count = StripsPerImage (when PlanarConfiguration = 1)
= SamplesPerPixel * StripsPerImage (when PlanarConfiguration = 2)
Default = None

4.6.5.2.4. JPEGInterchangeFormat

The offset to the start byte (SOI) of JPEG compressed thumbnail data. This shall not be used for primary image JPEG data.

Tag = 513 (201.H)
Type = LONG
Count = 1
Default = None

4.6.5.2.5. JPEGInterchangeFormatLength

The number of bytes of JPEG compressed thumbnail data. This is not used for primary image JPEG data. JPEG thumbnails are not divided but are recorded as a continuous JPEG bitstream from SOI to EOI. APPn and COM markers should not be recorded. Compressed thumbnails shall be recorded in no more than 64 KBytes, including all other data to be recorded in APP1.

Tag = 514 (202.H)
Type = LONG
Count = 1
Default = None

4.6.5.3. C. Tags Relating to Image Data Characteristics

4.6.5.3.1. TransferFunction

A transfer function for the image, described in tabular style. Normally this tag need not be used, since color space is specified in the color space information tag (ColorSpace).

Tag = 301 (12D.H)
Type = SHORT
Count = 3 * 256
Default = None

4.6.5.3.2. WhitePoint

The chromaticity of the white point of the image. Normally this tag need not be used, since color space is specified in the color space information tag (ColorSpace).

Tag = 318 (13E.H)
Type = RATIONAL
Count = 2
Default = None

4.6.5.3.3. PrimaryChromaticities

The chromaticity of the three primary colors of the image. Normally this tag need not be used, since color space is specified in the color space information tag (ColorSpace).

Tag = 319 (13F.H)
Type = RATIONAL
Count = 6
Default = None

4.6.5.3.4. YCbCrCoefficients

The matrix coefficients for transformation from RGB to YCbCr image data. No default is given in TIFF; but here the characteristics given in Annex D, "Color Space Guidelines," is used as the default.

Tag = 529 (211.H)
Type = RATIONAL
Count = 3
Default = See Annex D

4.6.5.3.5. ReferenceBlackWhite

The reference black point value and reference white point value. No defaults are given in TIFF, but the values below are given as defaults here. The value is set the default if the color space is specified by the color space information tag and an image with the optimal characteristics for this condition is recorded.

Tag = 532 (214.H)
Type = RATIONAL
Count = 6
Default = [0, 255, 0, 255, 0, 255] (when PhotometricInterpretation is RGB)
= [0, 255, 128, 128, 128, 128] (when PhotometricInterpretation is YCbCr)

4.6.5.4. D. Other Tags

4.6.5.4.1. ImageDescription

A character string giving the content description of the image. It is possible to add a description of the content or comment such as "1988 company picnic" or the like.

2-byte or larger character codes can not be used when ASCII is set as Type. When a 2-byte or larger code is necessary, UTF-8 shall be set as Type. The count is the value including NULL terminations.

Tag = 270 (10E.H)
Type = ASCII or UTF-8
Count = Any
Default = None

4.6.5.4.2. Make

The manufacturer of the recording equipment. This is the manufacturer of the DSC, scanner, video digitizer or other equipment that generated the image. When the field is left blank, it is treated as unknown.

Tag = 271 (10F.H)
Type = ASCII or UTF-8
Count = Any
Default = None

4.6.5.4.3. Model

The model name or model number of the equipment. This is the model name or model number of the DSC, scanner, video digitizer or other equipment that generated the image. When the field is left blank, it is treated as unknown.

Tag = 272 (110.H)
Type = ASCII or UTF-8
Count = Any
Default = None

4.6.5.4.4. Software

This tag records the name and version of the software or firmware of the camera or image input device used to generate the image. The detailed format is not specified, but it is recommended that the example shown below be followed. When the field is left blank, it is treated as unknown.

When any one of CameraFirmware, RawDevelopingSW, ImageEditingSW, and MetadataEditingSW tags, which is information related to this tag, is recorded, this tag shall also be recorded. It is recommended that the information written in this tag be the same as that written in any one of the CameraFirmware, RawDevelopingSW, and ImageEditingSW tags.

2-byte or larger character codes can not be used when ASCII is set as Type. When a 2-byte or larger code is necessary, UTF-8 shall be set as Type. The count is the value including NULL terminations.

Ex.) "Exif Software Version 1.00a"

Tag = 305 (131h)
Type = ASCII or UTF-8
Count = Any
Default = None

4.6.5.4.5. DateTime

The date and time of image creation. In this standard it is the date and time the file was changed. The format is "YYYY:MM:DD HH:MM:SS" with time shown in 24-hour format, and the date and time separated by one blank character [20.H]. When the date and time are unknown, all the character spaces except colons (":") should be filled with blank characters, or else the field should be filled with blank characters. The character string length is 20 Bytes including NULL for termination. When the field is left blank, it is treated as unknown.

Tag = 306 (132.H)
Type = ASCII
Count = 20
Default = None

4.6.5.4.6. Artist

This tag records name of the main person who created the image. The detailed format is not specified. When the field is left blank, it is treated as unknown.

When any one of CameraOwnerName, Photographer, and ImageEditor tags, which is information related to this tag, is recorded, this tag shall also be recorded. It is recommended that this tag contains the same value of either the CameraOwnerName, Photographer or ImageEditor tag.

2-byte or larger character codes can not be used when ASCII is set as Type. When a 2-byte or larger code is necessary, UTF-8 shall be set as Type. The count is the value including NULL terminations.

Tag = 315 (13Bh)
Type = ASCII or UTF-8
Count = Any
Default = None

4.6.5.4.7. Copyright

Copyright information. It is the copyright notice of the person or organization holding rights to the image.

2-byte or larger character codes can not be used when ASCII is set as Type. When a 2-byte or larger code is necessary, UTF-8 shall be set as Type. The count is the value including NULL terminations.

Tag = 33432 (8298.H)
Type = ASCII or UTF-8
Count = Any
Default = None

4.6.6. Exif IFD Attribute Information

The attribute information (field names and codes) recorded in the Exif IFD is given in Table 8 and Table 9 followed by an explanation of the contents.

Table 8 Exif IFD Attribute Information (1)

Tag Name	Field Name	Tag ID		Type	Count
		Dec	Hex		
A. Tags Relating to Version					
Exif version	ExifVersion	36864	9000	UNDEFINED	4
Supported Flashpix version	FlashpixVersion	40960	A000	UNDEFINED	4
B. Tag Relating to Image Data Characteristics					
Color space information	ColorSpace	40961	A001	SHORT	1
Gamma	Gamma	42240	A500	RATIONAL	1
C. Tags Relating to Image Configuration					
Meaning of each component	ComponentsConfiguration	37121	9101	UNDEFINED	4
Image compression mode	CompressedBitsPerPixel	37122	9102	RATIONAL	1
Valid image width	PixelXDimension	40962	A002	SHORT or LONG	1
Valid image height	PixelYDimension	40963	A003	SHORT or LONG	1
D. Tags Relating to User Information					
Manufacturer notes	MakerNote	37500	927C	UNDEFINED	Any
User comments	UserComment	37510	9286	UNDEFINED	Any
E. Tag Relating to Related File Information					
Related audio file	RelatedSoundFile	40964	A004	ASCII	13

F. Tags Relating to Date and Time					
Date and time of original data generation	DateTimeOriginal	36867	9003	ASCII	20
Date and time of digital data generation	DateTimeDigitized	36868	9004	ASCII	20
Offset data of DateTime	OffsetTime	36880	9010	ASCII	7
Offset data of DateTimeOriginal	OffsetTimeOriginal	36881	9011	ASCII	7
Offset data of DateTimeDigitized	OffsetTimeDigitized	36882	9012	ASCII	7
DateTime sub-seconds	SubSecTime	37520	9290	ASCII	Any
DateTimeOriginal sub-seconds	SubSecTimeOriginal	37521	9291	ASCII	Any
DateTimeDigitized sub-seconds	SubSecTimeDigitized	37522	9292	ASCII	Any
G. Tags Relating to Picture-Taking Conditions					
See Table 9					
H. Tags Relating to shooting situation					
Temperature	Temperature	37888	9400	SRATIONAL	1
Humidity	Humidity	37889	9401	RATIONAL	1
Pressure	Pressure	37890	9402	RATIONAL	1
WaterDepth	WaterDepth	37891	9403	SRATIONAL	1
Acceleration	Acceleration	37892	9404	RATIONAL	1
Camera elevation angle	CameraElevationAngle	37893	9405	SRATIONAL	1
I. Other Tags					
Unique image ID	ImageUniqueID	42016	A420	ASCII	33
Camera Owner Name	CameraOwnerName	42032	A430	ASCII or UTF-8	Any
Body Serial Number	BodySerialNumber	42033	A431	ASCII	Any
Lens Specification	LensSpecification	42034	A432	RATIONAL	4
Lens Make	LensMake	42035	A433	ASCII or UTF-8	Any
Lens Model	LensModel	42036	A434	ASCII or UTF-8	Any
Lens Serial Number	LensSerialNumber	42037	A435	ASCII	Any
Tiele name of Image	ImageTitle	42038	A436	ASCII or UTF-8	Any
Photographer name	Photographer	42039	A437	ASCII or UTF-8	Any
Person who edited the image	ImageEditor	42040	A438	ASCII or UTF-8	Any
Camera Firmware	CameraFirmware	42041	A439	ASCII or UTF-8	Any
RAW Developing Software	RAWDevelopingSoftware	42042	A43A	ASCII or UTF-8	Any
Image Editing Software	ImageEditingSoftware	42043	A43B	ASCII or UTF-8	Any
Metadata Editing Software	MetadataEditingSoftware	42044	A43C	ASCII or UTF-8	Any

Table 9 Exif IFD Attribute Information (2)

G. Tags Relating to Picture-Taking Conditions					
Exposure time	ExposureTime	33434	829A	RATIONAL	1
F number	FNumber	33437	829D	RATIONAL	1
Exposure program	ExposureProgram	34850	8822	SHORT	1
Spectral sensitivity	SpectralSensitivity	34852	8824	ASCII	Any
Photographic Sensitivity	PhotographicSensitivity	34855	8827	SHORT	Any
Optoelectric conversion factor	OECF	34856	8828	UNDEFINED	Any
Sensitivity Type	SensitivityType	34864	8830	SHORT	1
Standard Output Sensitivity	StandardOutputSensitivity	34865	8831	LONG	1
Recommended ExposureIndex	RecommendedExposureIndex	34866	8832	LONG	1
ISO Speed	ISOSpeed	34867	8833	LONG	1
ISO Speed Latitude yyy	ISOSpeedLatitudeyyy	34868	8834	LONG	1
ISO Speed Latitude zzz	ISOSpeedLatitudezzz	34869	8835	LONG	1
Shutter speed	ShutterSpeedValue	37377	9201	SRATIONAL	1
Aperture	ApertureValue	37378	9202	RATIONAL	1
Brightness	BrightnessValue	37379	9203	SRATIONAL	1
Exposure bias	ExposureBiasValue	37380	9204	SRATIONAL	1
Maximum lens aperture	MaxApertureValue	37381	9205	RATIONAL	1
Subject distance	SubjectDistance	37382	9206	RATIONAL	1
Metering mode	MeteringMode	37383	9207	SHORT	1
Light source	LightSource	37384	9208	SHORT	1
Flash	Flash	37385	9209	SHORT	1
Lens focal length	FocalLength	37386	920A	RATIONAL	1
Subject area	SubjectArea	37396	9214	SHORT	2 or 3 or 4
Flash energy	FlashEnergy	41483	A20B	RATIONAL	1
Spatial frequency response	SpatialFrequencyResponse	41484	A20C	UNDEFINED	Any
Focal plane X resolution	FocalPlaneXResolution	41486	A20E	RATIONAL	1
Focal plane Y resolution	FocalPlaneYResolution	41487	A20F	RATIONAL	1
Focal plane resolution unit	FocalPlaneResolutionUnit	41488	A210	SHORT	1
Subject location	SubjectLocation	41492	A214	SHORT	2
Exposure index	ExposureIndex	41493	A215	RATIONAL	1
Sensing method	SensingMethod	41495	A217	SHORT	1
File source	FileSource	41728	A300	UNDEFINED	1
Scene type	SceneType	41729	A301	UNDEFINED	1
CFA pattern	CFAPattern	41730	A302	UNDEFINED	Any
Custom image processing	CustomRendered	41985	A401	SHORT	1

	Exposure mode	ExposureMode	41986	A402	SHORT	1
	White balance	WhiteBalance	41987	A403	SHORT	1
	Digital zoom ratio	DigitalZoomRatio	41988	A404	RATIONAL	1
	Focal length in 35 mm film	FocalLengthIn35mmFilm	41989	A405	SHORT	1
	Scene capture type	SceneCaptureType	41990	A406	SHORT	1
	Gain control	GainControl	41991	A407	RATIONAL	1
	Contrast	Contrast	41992	A408	SHORT	1
	Saturation	Saturation	41993	A409	SHORT	1
	Sharpness	Sharpness	41994	A40A	SHORT	1
	Device settings description	DeviceSettingDescription	41995	A40B	UNDEFINED	Any
	Subject distance range	SubjectDistanceRange	41996	A40C	SHORT	1
	Composite image	CompositeImage	42080	A460	SHORT	1
	Source image number of composite image	SourceImageNumberOfCompositeImage	42081	A461	SHORT	2
	Source exposure times of composite image	SourceExposureTimesOfCompositeImage	42082	A462	UNDEFINED	Any

4.6.6.1. A. Tags Relating to Version

4.6.6.1.1. ExifVersion

The version of this standard supported. Nonexistence of this field is taken to mean nonconformance to the standard (see section 4.2). In according with conformance to this standard, this tag shall be recorded like "0300” as 4-byte ASCII. Since the type is UNDEFINED, it shall not be terminated with NULL.

Tag = 36864 (9000.H)
Type = UNDEFINED
Count = 4
Default = "0300”

4.6.6.1.2. FlashpixVersion

The Flashpix format[18] version supported by a FPXR file. If the FPXR function (see Annex F) supports Flashpix format Ver. 1.0[18], this is indicated similarly to ExifVersion by recording "0100" as 4-byte ASCII. Since the type is UNDEFINED, it shall not be terminated with NULL.

Tag = 40960(A000.H)
Type = UNDEFINED
Count = 4
Default = "0100"

0100 = Flashpix Format Version 1.0

Other = reserved

4.6.6.2. B. Tags Relating to ColorSpace

4.6.6.2.1. ColorSpace

The color space information tag (ColorSpace) is always recorded as the color space specifier. Normally sRGB (=1) is used to define the color space based on the PC monitor conditions and environment. If a color space other than sRGB is used, Uncalibrated (=FFFF.H) is set. Image data recorded as Uncalibrated may be treated as sRGB when it is converted to Flashpix (see Annex F). On sRGB see Annex D.

Tag = 40961 (A001.H)
Type = SHORT
Count = 1
Default = None

1 = sRGB

FFFF.H = Uncalibrated

Other = reserved

4.6.6.2.2. Gamma

Indicates the value of coefficient gamma. The formula of transfer function used for image reproduction is expressed as follows.

$$(\text{Reproduced value}) = (\text{Input value})\gamma$$

Both reproduced value and input value indicate normalized value, whose minimum value is 0 and maximum value is 1.

Tag = 42240 (A500.H)
Type = RATIONAL
Count = 1
Default = None

4.6.6.3. C. Tags Relating to Image Configuration

4.6.6.3.1. PixelXDimension

Information specific to compressed data. When a compressed file is recorded, the valid width of the meaningful image shall be recorded in this tag, whether or not there is padding data or a restart marker.

This tag shall not exist in an uncompressed file. For details see section 4.8.1 and Annex F.

Tag = 40962 (A002.H)
Type = SHORT or LONG
Count = 1
Default = None

4.6.6.3.2. PixelYDimension

Information specific to compressed data. When a compressed file is recorded, the valid height of the meaningful image shall be recorded in this tag, whether or not there is padding data or a restart marker. This tag shall not exist in an uncompressed file. For details see section 4.8.1 and Annex F. Since data padding is unnecessary in the vertical direction, the number of lines recorded in this valid image height tag will in fact be the same as that recorded in the SOF.

Tag = 40963 (A003.H)
Type = SHORT or LONG
Count = 1
Default = None

4.6.6.3.3. ComponentsConfiguration

Information specific to compressed data. The channels of each component are arranged in order from the 1st component to the 4th. For uncompressed data the data arrangement is given in the PhotometricInterpretation tag. However, since PhotometricInterpretation can only express the order of Y,Cb and Cr, this tag is provided for cases when compressed data uses components other than Y, Cb, and Cr and to enable support of other sequences.

Tag = 37121 (9101.H)
Type = UNDEFINED
Count = 4
Default = 4 5 6 0 (if RGB uncompressed)
1 2 3 0 (other cases)

0 = does not exist
1 = Y
2 = Cb
3 = Cr
4 = R
5 = G
6 = B
Other = reserved

4.6.6.3.4. CompressedBitsPerPixel

Information specific to compressed data. The compression mode used for a compressed image is indicated in unit bits per pixel.

Tag = 37122 (9102.H)
Type = RATIONAL
Count = 1
Default = None

4.6.6.4. D. Tags Relating to User Information

4.6.6.4.1. MakerNote

A tag for manufacturers of Exif/DCF writers to record any desired information. The contents are up to the manufacturer, but this tag shall not be used for any other than its intended purpose.

Tag = 37500 (927C.H)
Type = UNDEFINED
Count = Any
Default = None

4.6.6.4.2. UserComment

A tag for Exif users to freely write keywords or comments on the image. This is a multicode-compatible string and shall be entered in a form along with an character identifier code to identify the character code to be used. See section 4.6.4 for details on the form.

Tag = 37510 (9286.H)
Type = UNDEFINED
Count = Any
Default = None

4.6.6.5. E. Tag Relating to Related File

4.6.6.5.1. RelatedSoundFile

This tag is used to record the name of an audio file related to the image data. The only relational information recorded here is the Exif audio file name and extension (an ASCII string consisting of 8 characters + '.' + 3 characters). The path is not recorded. Stipulations on audio are given in section 5.6.3 "erel". File naming conventions are given in section 5.7.1.

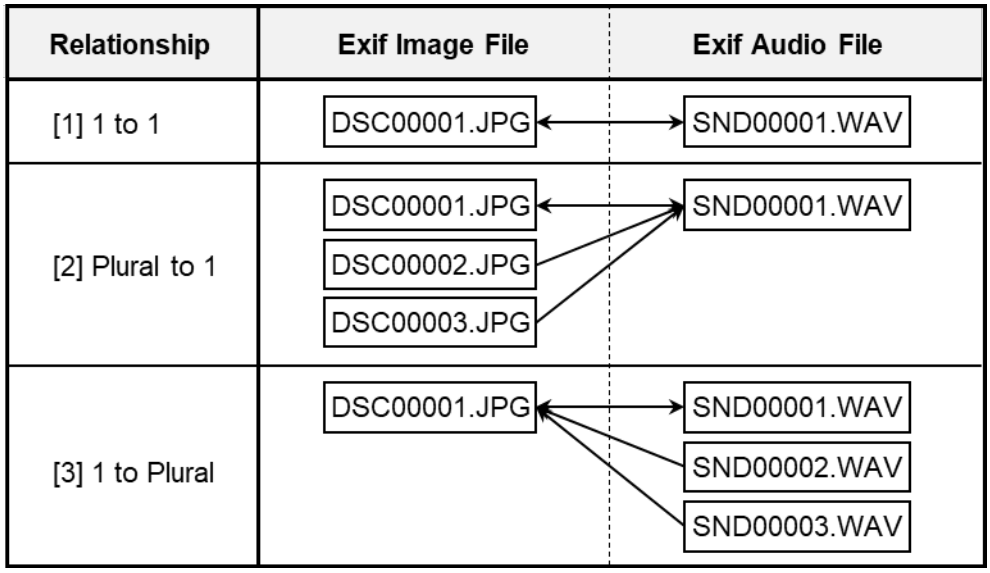
When using this tag, audio files shall be recorded in conformance to the Exif audio format. Writers can also store the data such as Audio within APP2 as Flashpix extension stream data.

Audio files shall be recorded in conformance to the Exif audio format.

The mapping of Exif image files and audio files is done in any of the three ways shown in Table 10. If multiple files are mapped to one file as in [2] or [3] of this Table 10, the above format shall be used to record just one audio file name. If there are multiple audio files, the first recorded file shall be given.In the case of [3] in Table 10, for example, for the Exif image file "DSC00001. JPG" only "SND00001. WAV" is given as the related Exif audio file.

When there are three Exif audio files "SND00001. WAV", "SND00002. WAV" and "SND00003. WAV", the Exif image file name for each of them, "DSC00001. JPG," is indicated. By combining multiple relational information, a variety of playback possibilities can be supported. The method of using relational information is left to the implementation on the playback side. Since this information is an ASCII character string, it shall be terminated with NULL.

Table 10 Mapping between Image and Audio Files



When this tag is used to map audio files, the relation of the audio file to image data shall also be indicated on the audio file end.

Tag = 40964 (A004.H)
Type = ASCII
Count = 13
Default = None

4.6.6.6. F. Tags Relating to Date and Time

4.6.6.6.1. DateTimeOriginal

The date and time when the original image data was generated. For a DSC the date and time the picture was taken are recorded. The format is "YYYY:MM:DD HH:MM:SS" with time shown in 24-hour format, and the date and time separated by one blank character [20.H]. When the date and time are unknown, all the character spaces except colons (":") should be filled with blank characters, or else the field should be filled with blank characters. The character string length is 20 Bytes including NULL for termination. When the field is left blank, it is treated as unknown.

Tag = 36867 (9003.H)
Type = ASCII
Count = 20
Default = None

4.6.6.6.2. DateTimeDigitized

The date and time when the image was stored as digital data. If, for example, an image was captured by DSC and at the same time the file was recorded, then the DateTimeOriginal and DateTimeDigitized will have the same contents. The format is "YYYY:MM:DD HH:MM:SS" with time shown in 24-hour format, and the date and time separated by one blank character [20.H]. When the date and time are unknown, all the character spaces except colons (":") should be filled with blank characters, or else the field should be filled with blank characters. The character string length is 20 Bytes including NULL for termination. When the field is left blank, it is treated as unknown.

Tag = 36868 (9004.H)
Type = ASCII
Count = 20
Default = None

4.6.6.6.3. OffsetTime

A tag used to record the offset from UTC (the time difference from Universal Time Coordinated including daylight saving time) of the time of DateTime tag. The format when recording the offset is "±HH:MM". The part of "±" shall be recorded as "+" or "-". When the offset are unknown, all the character spaces except colons (":") should be filled with blank characters, or else the field should be filled with blank characters. The character string length is 7 Bytes including NULL for termination. When the field is left blank, it is treated as unknown.

Tag = 36880 (9010.H)
Type = ASCII
Count = 7
Default = None

4.6.6.6.4. OffsetTimeOriginal

A tag used to record the offset from UTC (the time difference from Universal Time Coordinated including daylight saving time) of the time of DateTimeOriginal tag. The format when recording the offset is "±HH:MM". The part of "±" shall be recorded as "+" or "-". When the offset are unknown, all the character spaces except colons (":") should be filled with blank characters, or else the field should be filled with blank characters. The character string length is 7 Bytes including NULL for termination. When the field is left blank, it is treated as unknown.

Tag = 36881 (9011.H)
Type = ASCII
Count = 7
Default = None

4.6.6.6.5. OffsetTimeDigitized

A tag used to record the offset from UTC (the time difference from Universal Time Coordinated including daylight saving time) of the time of DateTimeDigitized tag. The format when recording the offset is "±HH:MM". The part of "±" shall be recorded as "+" or "-". When the offset are unknown, all the character spaces except colons (":") should be filled with blank characters, or else the field should be filled with blank characters. The character string length is 7 Bytes including NULL for termination. When the field is left blank, it is treated as unknown.

Tag = 36882 (9012.H)
Type = ASCII
Count = 7
Default = None

4.6.6.6.6. SubsecTime

A tag used to record fractions of seconds for the DateTime tag.

If the string length is longer than the number of valid digits, the digits are aligned with the start of the area and the rest is filled with blank characters [20.H]. If the sub-second data is unknown, the entire area should be filled with blank characters. See the recording examples under " Note Recording sub-second data" below.

Tag = 37520 (9290.H)
Type = ASCII
Count = Any
Default = None

4.6.6.6.7. SubsecTimeOriginal

A tag used to record fractions of seconds for the DateTimeOriginal tag.

If the string length is longer than the number of valid digits, the digits are aligned with the start of the area and the rest is filled with blank characters [20.H]. If the sub-second data is unknown, the entire area should be filled with blank characters. See the recording examples under " Note Recording sub-second data" below.

Tag = 37521 (9291.H)
Type = ASCII
Count = Any
Default = None

4.6.6.6.8. SubsecTimeDigitized

A tag used to record fractions of seconds for the DateTimeDigitized tag.

If the string length is longer than the number of valid digits, the digits are aligned with the start of the area and the rest is filled with blank characters [20.H]. If the sub-second data is unknown, the entire area should be filled with blank characters. See the recording examples under " Note Recording sub-second data" below.

Tag = 37522 (9292.H)
Type = ASCII
Count = Any
Default = None

Note Recording sub-second data

The followings are examples of subsec data. Ex.: September 9, 1998, 9:15:30.130 (the number of valid digits is up to the third decimal place)

DateTime 1998:09:01 09:15:30 [NULL]

SubSecTime 130 [NULL]

Examples when sub-second data is 0.130 seconds:

Ex. 1) '1', '3', '0', [NULL]

Ex. 2) '1', '3', '0', [20.H], [NULL]

Ex. 3) '1', '3', '0', [20.H], [20.H], [20.H], [20.H], [20.H], [NULL]

Example when sub-second data is unknown:

Ex. 4) [20.H], [20.H], [20.H], [20.H], [20.H], [20.H], [20.H], [20.H], [NULL]

4.6.6.7. G. Tags Relating to Picture-Taking Conditions

4.6.6.7.1. ExposureTime

Exposure time, given in seconds (sec).

Tag = 33434 (829A.H)
Type = RATIONAL
Count = 1
Default = None

4.6.6.7.2. FNumber

The F number.

Tag = 33437 (829D.H)
Type = RATIONAL
Count = 1
Default = None

4.6.6.7.3. ExposureProgram

The class of the program used by the camera to set exposure when the picture is taken. The tag values are as follows.

Tag = 34850 (8822.H)
Type = SHORT
Count = 1
Default = 0

0 = Not defined

1 = Manual

2 = Normal program

3 = Aperture priority

4 = Shutter priority

5 = Creative program (biased toward depth of field)
6 = Action program (biased toward fast shutter speed)
7 = Portrait mode (for closeup photos with the background out of focus)
8 = Landscape mode (for landscape photos with the background in focus)
Other = reserved

4.6.6.7.4. SpectralSensitivity

Indicates the spectral sensitivity of each channel of the camera used. The tag value is an ASCII string compatible with the standard developed by the ASTM Technical committee.

Tag = 34852 (8824.H)
Type = ASCII
Count = Any
Default = None

4.6.6.7.5. PhotographicSensitivity

This tag indicates the sensitivity of the camera or input device when the image was shot. More specifically, it indicates one of the following values that are parameters defined in ISO 12232: standard output sensitivity (SOS), recommended exposure index (REI), or ISO speed. Accordingly, if a tag corresponding to a parameter that is designated by a SensitivityType tag is recorded, the values of the tag and of this PhotographicSensitivity tag are the same. However, if the value is 65535 (the maximum value of SHORT) or higher, the value of this tag shall be 65535. When recording this tag, the SensitivityType tag should also be recorded. In addition, while “Count = Any”, only 1 count should be used when recording this tag.

Note that this tag was referred to as “ISOSpeedRatings” in versions of this standard up to Version 2.21. See Annex G for use of sensitivity-related tags.

Tag = 34855 (8827.H)
Type = SHORT
Count = Any
Default = None

4.6.6.7.6. OECF

Indicates the Opto-Electric Conversion Function (OECF) specified in ISO 14524. OECF is the relationship between the camera optical input and the image values.

Tag = 34856 (8828.H)
Type = UNDEFINED
Count = Any
Default = None

When this tag records an OECF of m rows and n columns, the values are as in Figure 16.

Length	Type	Meaning
2	SHORT	Columns = n
2	SHORT	Rows = m
Any	ASCII	0th column item name (NULL terminated)
:	:	:
Any	ASCII	(n-1)th column item name (NULL terminated)
8	SRATIONAL	OECF value [0,0]
:	:	:
8	SRATIONAL	OECF value [n-1,0]
8	SRATIONAL	OECF value [0,m-1]
:	:	:
8	SRATIONAL	OECF value [n-1,m-1]

Figure 16 OECF Description

Table 11 gives a simple example.

Table 11 Example of Exposure and RGB Output Level

Camera log Aperture	R Output Level	G Output Level	B Output Level
-3.0	10.2	12.4	8.9
-2.0	48.1	47.5	48.3
-1.0	150.2	152.0	149.8

4.6.6.7.7. SensitivityType

The SensitivityType tag indicates which one of the parameters of ISO12232 is the PhotographicSensitivity tag. Although it is an optional tag, it should be recorded when a PhotographicSensitivity tag is recorded. Value = 4, 5, 6, or 7 may be used in case that the values of plural parameters are the same. See Annex G for use of sensitivity-related tags.

Tag = 34864 (8830.H)
Type = SHORT
Count = 1
Default = None

0 = Unknown
1 = Standard output sensitivity (SOS)

2 = Recommended exposure index (REI)

3 = ISO speed

4 = Standard output sensitivity (SOS) and recommended exposure index (REI)

5 = Standard output sensitivity (SOS) and ISO speed

6 = Recommended exposure index (REI) and ISO speed

7 = Standard output sensitivity (SOS) and recommended exposure index (REI) and ISO speed

Other = reserved

4.6.6.7.8. StandardOutputSensitivity

This tag indicates the standard output sensitivity value of a camera or input device defined in ISO 12232[11]. When recording this tag, the PhotographicSensitivity and SensitivityType tags shall also be recorded. See Annex G for use of sensitivity-related tags.

Tag = 34865 (8831.H)
Type = LONG
Count = 1
Default = None

4.6.6.7.9. RecommendedExposureIndex

This tag indicates the recommended exposure index value of a camera or input device defined in ISO 12232[11]. When recording this tag, the PhotographicSensitivity and SensitivityType tags shall also be recorded. See Annex G for use of sensitivity-related tags.

Tag = 34866 (8832.H)
Type = LONG
Count = 1
Default = None

4.6.6.7.10. ISO Speed

This tag indicates the ISO speed value of a camera or input device that is defined in ISO 12232[11]. When recording this tag, the PhotographicSensitivity and SensitivityType tags shall also be recorded.

See Annex G for use of sensitivity-related tags.

Tag = 34867 (8833.H)
Type = LONG
Count = 1
Default = None

4.6.6.7.11. ISOSpeedLatitudeyyy

This tag indicates the ISO speed latitude yyy value of a camera or input device that is defined in ISO 12232[11].

However, this tag shall not be recorded without ISOSpeed and ISOSpeedLatitudezzz.

See Annex G for use of sensitivity-related tags.

Tag = 34868 (8834.H)
Type = LONG
Count = 1
Default = None

4.6.6.7.12. ISOSpeedLatitudezzz

This tag indicates the ISO speed latitude zzz value of a camera or input device that is defined in ISO 12232[11].

However, this tag shall not be recorded without ISOSpeed and ISOSpeedLatitudeyyy.

See Annex G for use of sensitivity-related tags.

Tag = 34869 (8835.H)
Type = LONG
Count = 1
Default = None

4.6.6.7.13. ShutterSpeedValue

Shutter speed. The unit is the Additive System of Photographic Exposure (APEX) setting (see Annex C).

Tag = 37377 (9201.H)
Type = SRATIONAL
Count = 1
Default = None

4.6.6.7.14. ApertureValue

The lens aperture. The unit is the APEX value.

Tag = 37378 (9202.H)
Type = RATIONAL
Count = 1
Default = None

4.6.6.7.15. BrightnessValue

The value of brightness. The unit is the APEX value. Ordinarily it is given in the range of -99.99 to 99.99. Note that if the numerator of the recorded value is FFFFFFFF.H, Unknown shall be indicated.

Tag = 37379 (9203.H)
Type = SRATIONAL
Count = 1
Default = None

4.6.6.7.16. ExposureBiasValue

The exposure bias. The unit is the APEX value. Ordinarily it is given in the range of -99.99 to 99.99.

Tag = 37380 (9204.H)
Type = SRATIONAL
Count = 1
Default = None

4.6.6.7.17. MaxApertureValue

The smallest F number of the lens. The unit is the APEX value. Ordinarily it is given in the range of 00.00 to 99.99, but it is not limited to this range.

Tag = 37381 (9205.H)
Type = RATIONAL
Count = 1
Default = None

4.6.6.7.18. SubjectDistance

The distance to the subject, given in meters. Note that if the numerator of the recorded value is FFFFFFFF.H, Infinity shall be indicated; and if the numerator is 0, Distance unknown shall be indicated.

Tag = 37382 (9206.H)
Type = RATIONAL
Count = 1
Default = None

4.6.6.7.19. MeteringMode

The metering mode.

Tag = 37383 (9207.H)
Type = SHORT
Count = 1
Default = 0

0 = unknown

1 = Average

2 = CenterWeightedAverage

3 = Spot

4 = Multi-spot

5 = Pattern

6 = Partial

255 = other

Other = reserved

4.6.6.7.20. LightSource

The kind of light source.

Tag = 37384 (9208.H)
Type = SHORT
Count = 1
Default = 0

0 = unknown
1 = Daylight
2 = Fluorescent
3 = Tungsten (incandescent light)
4 = Flash
9 = Fine weather
10 = Cloudy weather
11 = Shade
12 = Daylight fluorescent (D 5700 - 7100K)
13 = Day white fluorescent (N 4600 - 5500K)
14 = Cool white fluorescent (W 3800 - 4500K)
15 = White fluorescent (WW 3250 - 3800K)
16 = Warm white fluorescent (L 2600 - 3250K)
17 = Standard light A
18 = Standard light B
19 = Standard light C
20 = D55
21 = D65
22 = D75
23 = D50
24 = ISO studio tungsten
255 = other light source
Other = reserved

4.6.6.7.21. Flash

This tag indicates the status of flash when the image was shot. Bit 0 indicates the flash firing status, bits 1 and 2 indicate the flash return status, bits 3 and 4 indicate the flash mode, bit 5 indicates whether the flash function is present, and bit 6 indicates "red eye" mode (see Figure 17).

Tag = 37385 (9209.H)
Type = SHORT
Count = 1
Default = None

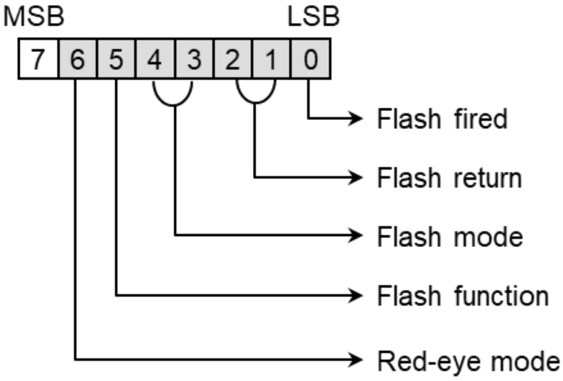


Figure 17 Bit Coding of the Flash Tag

Values for bit 0 indicating whether the flash fired.

0b = Flash did not fire.
1b = Flash fired.

Values for bits 1 and 2 indicating the status of returned light.

00b = No strobe return detection function
01b = reserved
10b = Strobe return light not detected.
11b = Strobe return light detected.

Values for bits 3 and 4 indicating the camera's flash mode.

00b = unknown
01b = Compulsory flash firing
10b = Compulsory flash suppression
11b = Auto mode

Values for bit 5 indicating the presence of a flash function.

0b = Flash function present
1b = No flash function

Values for bit 6 indicating the camera's red-eye mode.

0b = No red-eye reduction mode or unknown
1b = Red-eye reduction supported

4.6.6.7.22. SubjectArea

This tag indicates the location and area of the main subject in the overall scene.

Tag = 37396 (9214.H)
Type = SHORT
Count = 2 or 3 or 4
Default = None

The subject location and area are defined by Count values as follows.

Count = 2 : Indicates the location of the main subject as coordinates. The first value is the X coordinate and the second is the Y coordinate.

Count = 3 : The area of the main subject is given as a circle. The circular area is expressed as center coordinates and diameter. The first value is the center X coordinate, the second is the center Y coordinate, and the third is the diameter. (See Figure 18.)

Count = 4 : The area of the main subject is given as a rectangle. The rectangular area is expressed as center coordinates and area dimensions. The first value is the center X coordinate, the second is the center Y coordinate, the third is the width of the area, and the fourth is the height of the area. (See Figure 19.)

Note that the coordinate values, width, and height are expressed in relation to the upper left as origin, prior to rotation processing as per the Rotation tag.

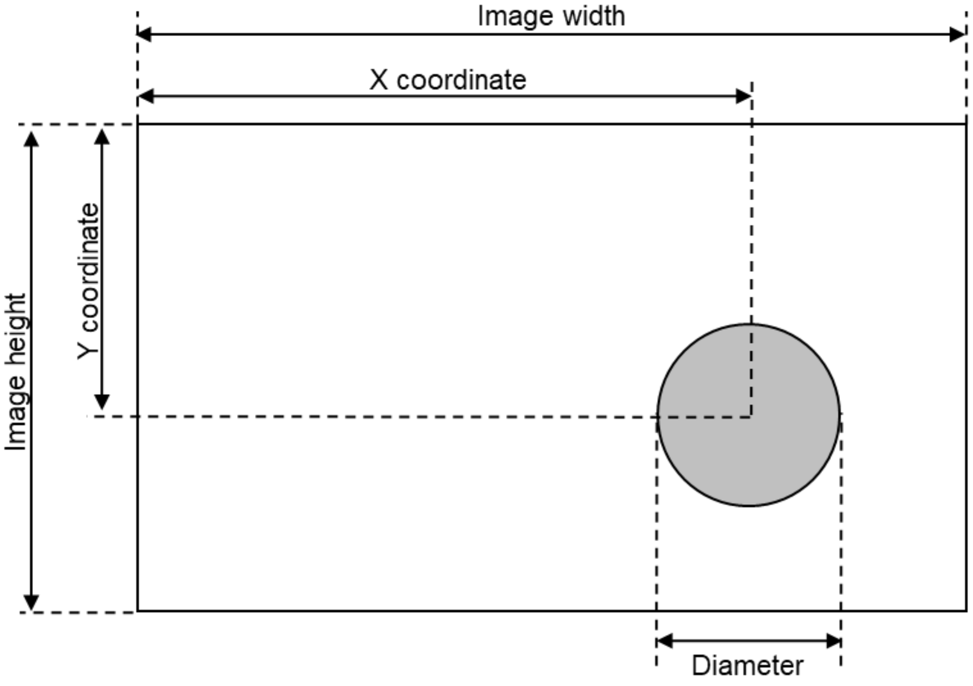


Figure 18 Circular area designation

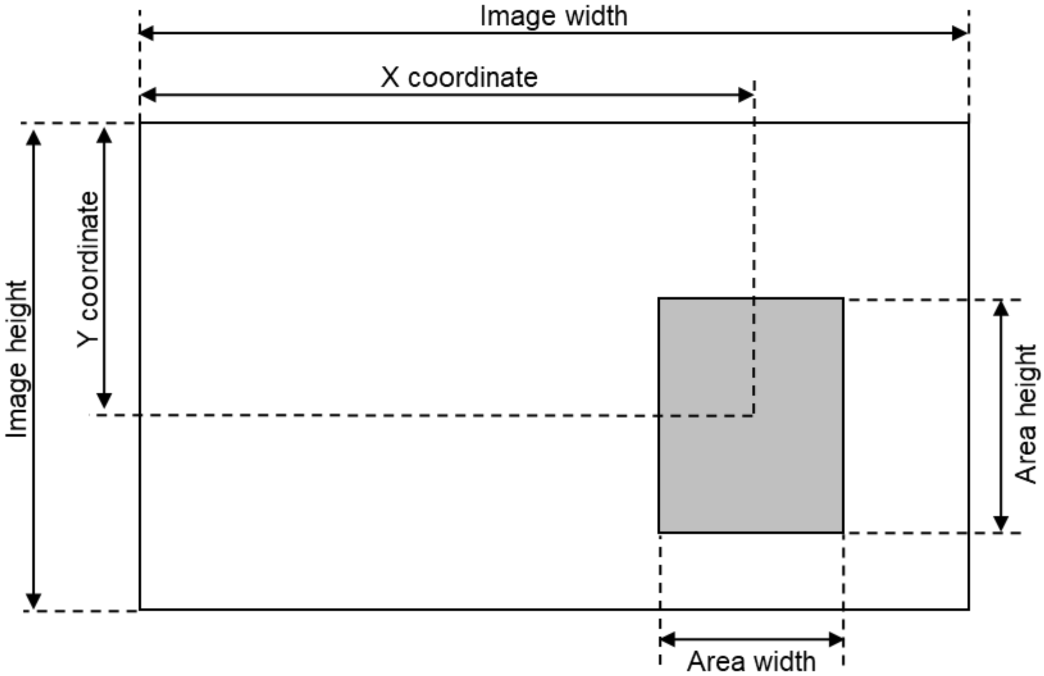


Figure 19 Rectangular area designation

4.6.6.7.23. FocalLength

The actual focal length of the lens, in mm. Conversion is not made to the focal length of a 35 mm film camera.

Tag = 37386 (920A.H)
Type = RATIONAL
Count = 1
Default = None

4.6.6.7.24. FlashEnergy

Indicates the strobe energy at the time the image is captured, as measured in Beam Candle Power Seconds (BCPS).

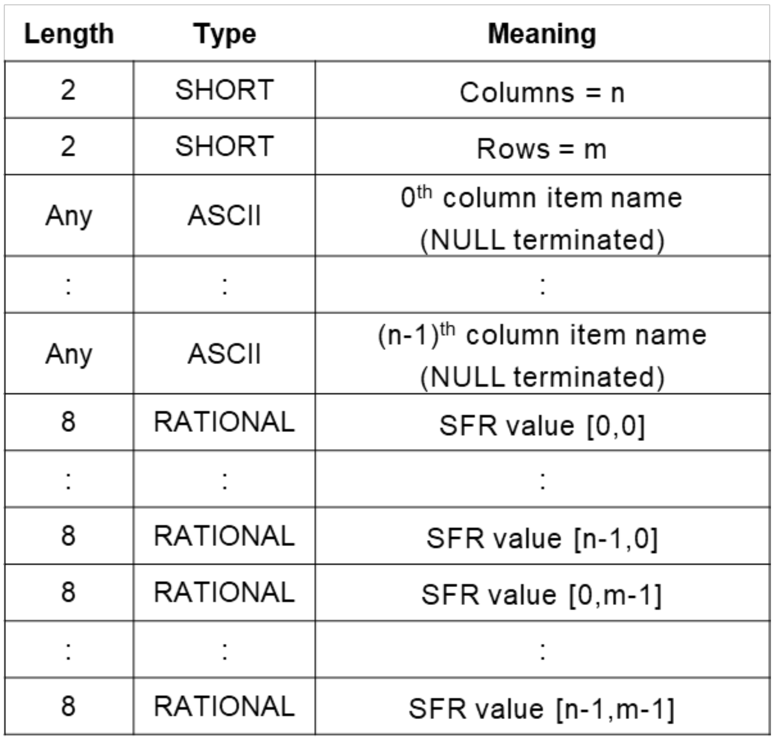
Tag = 41483 (A20B.H)
Type = RATIONAL
Count = 1
Default = None

4.6.6.7.25. SpatialFrequencyResponse

This tag records the camera or input device spatial frequency table and SFR values in the direction of image width, image height, and diagonal direction, as specified in ISO 12233.

Tag = 41484 (A20CH)
Type = UNDEFINED
Count = Any
Default = None

When the spatial frequency response for m rows and n columns is recorded, the values are as shown in Figure 20.



Length	Type	Meaning
2	SHORT	Columns = n
2	SHORT	Rows = m
Any	ASCII	0th column item name (NULL terminated)
:	:	:
Any	ASCII	(n-1)th column item name (NULL terminated)
8	RATIONAL	SFR value [0,0]
:	:	:
8	RATIONAL	SFR value [n-1,0]
8	RATIONAL	SFR value [0,m-1]
:	:	:
8	RATIONAL	SFR value [n-1,m-1]

Figure 20 Spatial Frequency Response Description

Table 12 gives a simple example.

Table 12 Example of Spatial Frequency Response

Spatial Frequency (lw/ph)	Along Image Width	Along Image Height
0.1	1.00	1.00
0.2	0.90	0.95
0.3	0.80	0.85

4.6.6.7.26. FocalPlaneXResolution

Indicates the number of pixels in the image width (X) direction per FocalPlaneResolutionUnit on the camera focal plane. This tag records the focal plane resolution of the primary image which is recorded as a file instead of the resolution of the image sensor in the camera.

Tag = 41486 (A20E.H)
Type = RATIONAL
Count = 1
Default = None

4.6.6.7.27. FocalPlaneYResolution

Indicates the number of pixels in the image height (Y) direction per FocalPlaneResolutionUnit on the camera focal plane. This tag records the focal plane resolution of the primary image which is recorded as a file instead of the resolution of the image sensor in the camera.

Tag = 41487 (A20F.H)
Type = RATIONAL
Count = 1
Default = None

4.6.6.7.28. FocalPlaneResolutionUnit

Indicates the unit for measuring FocalPlaneXResolution and FocalPlaneYResolution. This value is the same as the ResolutionUnit.

Tag = 41488 (A210.H)
Type = SHORT
Count = 1
Default = 2 (inch)

Note on use of tags concerning focal plane resolution

It should be noted carefully that the data from the image sensor is resampled. These tags are used at the same time as a FocalLength tag when the angle of field of the recorded image is to be calculated precisely.

4.6.6.7.29. SubjectLocation

Indicates the location of the main subject in the scene. The value of this tag represents the pixel at the center of the main subject relative to the upper left, prior to rotation processing as per the Orientation tag.

The first value indicates the X column number and second indicates the Y row number.

When a camera records the main subject location, it is recommended that the SubjectArea tag be used instead of this tag.

Tag = 41492 (A214.H)
Type = SHORT
Count = 2
Default = None

4.6.6.7.30. ExposureIndex

Indicates the exposure index selected on the camera or input device at the time the image is captured.

Tag = 41493 (A215.H)
Type = RATIONAL
Count = 1
Default = None

4.6.6.7.31. SensingMethod

Indicates the image sensor type on the camera or input device. The values are as follows.

Tag = 41495 (A217.H)
Type = SHORT
Count = 1
Default = None

1 = Not defined
2 = One-chip color area sensor
3 = Two-chip color area sensor
4 = Three-chip color area sensor
5 = Color sequential area sensor
7 = Trilinear sensor
8 = Color sequential linear sensor
Other = reserved

4.6.6.7.32. FileSource

Indicates the image source. If a DSC recorded the image, this tag value always shall be set to 3.

Tag = 41728 (A300.H)
Type = UNDEFINED
Count = 1
Default = 3

0 = others
1 = scanner of transparent type
2 = scanner of reflex type
3 = DSC
Other = reserved

4.6.6.7.33. SceneType

Indicates the type of scene. If a DSC recorded the image, this tag value shall always be set to 1, indicating that the image was directly photographed.

Tag = 41729 (A301.H)
Type = UNDEFINED
Count = 1
Default = 1

1 = A directly photographed image
Other = reserved

4.6.6.7.34. CFAPattern

Indicates the color filter array (CFA) geometric pattern of the image sensor when a one-chip color area sensor is used. It does not apply to all sensing methods.

Tag = 41730 (A302.H)
Type = UNDEFINED
Count = Any
Default = None

Figure 21 shows how a CFA pattern is recorded for a one-chip color area sensor when the color filter array is repeated in m x n (vertical x lateral) pixel units.

Length	Type	Meaning
2	SHORT	Horizontal repeat pixel unit = n
2	SHORT	Vertical repeat pixel unit = m
1	BYTE	CFA value [0.0]
:	:	:
1	BYTE	CFA value [n-1.0]
1	BYTE	CFA value [0.m-1]
:	:	:
1	BYTE	CFA value [n-1.m-1]

Figure 21 CFA Pattern Description

The relation of color filter color to CFA value is shown in Table 13.

Table 13 Color Filter Color and CFA Value

Filter Color	CFA Value
RED	00.H
GREEN	01.H
BLUE	02.H
CYAN	03.H
MAGENTA	04.H

YELLOW	05.H
WHITE	06.H

For example, when the CFA pattern values are {0002.H, 0002.H, 01.H, 00.H, 02.H, 01.H}, the color filter array is as shown in Figure 22.

G	R	G	R	……..
B	G	B	G	……..
G	R	G	R	……..
B	G	B	G	……..
:	:	:	:	

Figure 22 Color Filter Array

4.6.6.7.35. CustomRendered

This tag indicates the use of special processing on image data, such as rendering geared to output.

When special processing is performed, the Exif/DCF reader is expected to disable or minimize any further processing.

Tag = 41985 (A401.H)
Type = SHORT
Count = 1
Default = 0

0 = Normal process
1 = Custom process
Other = reserved

4.6.6.7.36. ExposureMode

This tag indicates the exposure mode set when the image was shot. In auto-bracketing mode, the camera shoots a series of frames of the same scene at different exposure settings.

Tag = 41986 (A402.H)
Type = SHORT
Count = 1
Default = None

0 = Auto exposure
1 = Manual exposure
2 = Auto bracket
Other = reserved

4.6.6.7.37. WhiteBalance

This tag indicates the white balance mode set when the image was shot.

Tag = 41987 (A403.H)
Type = SHORT
Count = 1
Default = None

0 = Auto white balance
1 = Manual white balance
Other = reserved

4.6.6.7.38. DigitalZoomRatio

This tag indicates the digital zoom ratio when the image was shot. If the numerator of the recorded value is 0, this indicates that digital zoom was not used.

Tag = 41988 (A404.H)
Type = RATIONAL
Count = 1
Default = None

4.6.6.7.39. FocalLengthIn35mmFilm

This tag indicates the equivalent focal length assuming a 35mm film camera, in mm. A value of 0 means the focal length is unknown. Note that this tag differs from the FocalLength tag.

Tag = 41989 (A405.H)
Type = SHORT
Count = 1
Default = None

4.6.6.7.40. SceneCaptureType

This tag indicates the type of scene that was shot. It may also be used to record the mode in which the image was shot. Note that this differs from the scene type (SceneType) tag.

Tag = 41990 (A406.H)
Type = SHORT
Count = 1
Default = 0

0 = Standard
1 = Landscape
2 = Portrait
3 = Night scene
Other = reserved

4.6.6.7.41. GainControl

This tag indicates the degree of overall image gain adjustment.

Tag = 41991 (A407.H)
Type = SHORT
Count = 1
Default = None

0 = None
1 = Low gain up
2 = High gain up
3 = Low gain down
4 = High gain down
Other = reserved

4.6.6.7.42. Contrast

This tag indicates the direction of contrast processing applied by the camera when the image was shot.

Tag = 41992 (A408.H)
Type = SHORT
Count = 1
Default = 0

0 = Normal
1 = Soft
2 = Hard
Other = reserved

4.6.6.7.43. Saturation

This tag indicates the direction of saturation processing applied by the camera when the image was shot.

Tag = 41993 (A409.H)
Type = SHORT
Count = 1
Default = 0

0 = Normal
1 = Low saturation
2 = High saturation
Other = reserved

4.6.6.7.44. Sharpness

This tag indicates the direction of sharpness processing applied by the camera when the image was shot.

Tag = 41994 (A40A.H)
Type = SHORT
Count = 1
Default = 0

0 = Normal

1 = Soft

2 = Hard

Other = reserved

4.6.6.7.45. DeviceSettingDescription

This tag indicates information on the picture-taking conditions of a particular camera model.

The tag is used only to indicate the picture-taking conditions in the Exif/DCF reader.

Tag = 41995 (A40B.H)
Type = UNDEFINED
Count = Any
Default = None

The information is recorded in the format shown in Figure 23. The data is recorded in Unicode using SHORT type for the number of display rows and columns and UNDEFINED type for the camera settings. The Unicode (UTF-16) string including Signature is NULL terminated. The specifics of the Unicode string are as given in UCS (ISO/IEC 10646-1)[21].

Length	Type	Meaning
2	SHORT	Display columns
2	SHORT	Display rows
Any	UNDEFINED	Camera setting-1
Any	UNDEFINED	Camera setting-2
:	:	:
Any	UNDEFINED	Camera setting-n

Figure 23 Format used to record picture-taking conditions

4.6.6.7.46. SubjectDistanceRange

This tag indicates the distance to the subject.

Tag = 41996 (A40C.H)
Type = SHORT
Count = 1
Default = None

0 = unknown

1 = Macro

2 = Close view

3 = Distant view

Other = reserved

4.6.6.7.47. CompositeImage

This tag indicates whether the recorded image is a composite image* or not. “General composite image” specified by “the recorded value = 2“ means a composite image and the generating method is not identified. “Composite image captured when shooting” specified by “the recorded value = 3“ means a composite image generated only from multiple source images (tentatively recorded images) those are sequentially captured by the image sensor when shooting (no need for all source images to be used), and also the picture taking conditions (such as aperture value, subject distance, light source, lens focal length) and the objective area (field of view) are considered to be constant during the capturing of all the source images. When the recorded value = 3, ”SourceImageNumberOfCompositeImage” tag and “SourceExposureTimesOfCompositeImage” shall be recorded.

* A composite image means that is generated from multiple taken images (source images).

Tag = 42080 (A460.H)
Type = SHORT
Count = 1
Default = 0

0 = unknown

1 = non-composite image

2 = General composite image

3 = Composite image captured when shooting

Other = reserved

4.6.6.7.48. SourceImageNumberOfCompositeImage

This tag indicates the number of the source images (tentatively recorded images) captured for a composite Image. See Figure 24 for the specific method of recording.

Tag = 42081 (A461.H)
Type = SHORT
Count = 2
Default = None

Length	Type	Meaning
2	SHORT	Total number of source images = n $_{TOTAL}$ (n $_{TOTAL} \geq 2$)
2	SHORT	Number of source images used* in the composite Image = n $_{USED}$ (n $_{USED} \geq 2$) This value is invalid when 0 is recorded.

(*) : Criteria for "used" are not specified

Figure 24 Format used to record SourceImageNumberOfCompositeImage

4.6.6.7.49. SourceExposureTimesOfCompositeImage

For a composite image, this tag records the parameters relating exposure time of the exposures for generating the said composite image, such as respective exposure times of captured source images (tentatively recorded images). The unit is seconds (sec). See Figure 25 for the specific method of recording.

Tag = 42082 (A462.H)
Type = UNDEFINED
Count = Any (Total byte number of tag elements)
Default = None

Length	Type	Meaning
8	RATIONAL	Total exposure period (from the first beginning of exposure to the last ending of exposure, including non-exposure periods). This value is invalid when 0/0 is recorded.
8	RATIONAL	Sum of respective exposure times of all source images. This value is invalid when 0/0 is recorded.
8	RATIONAL	Sum of respective exposure times of used* source images. This value is invalid when 0/0 is recorded.
8	RATIONAL	Max exposure time of all source images. This value is invalid when 0/0 is recorded.
8	RATIONAL	Max exposure time of used* source images. This value is invalid when 0/0 is recorded.
8	RATIONAL	Minimum exposure time of all source images. This value is invalid when 0/0 is recorded.
8	RATIONAL	Minimum exposure time of used* source images. This value is invalid when 0/0 is recorded.

The following is a list format to record respective exposure times of all source images.		
2	SHORT	Number of sequences: m (m ≥ 1) When 0 is recorded as this value, the following values shall not be recorded since it is invalid.
2	SHORT	Number of source images in the sequence: n (n x m ≥ 2)
8	RATIONAL	Exposure time of the 1st source image.
8	RATIONAL	Exposure time of the 2nd source image.
8	RATIONAL	Exposure time of the 3rd source image.
:	:	:
8	RATIONAL	Exposure time of the nth source image.
		(*) : Criteria for “used” are not specified

Figure 25 Format used to record SourceExposureTimesOfCompositeImage

4.6.6.8. H. Tags Relating to Shooting Situation

4.6.6.8.1. Outline

Tags relating to shooting situation indicate the respective situations of the photographing scenes. If the shooting situation is recorded including the ambient circumstance, the photographing locations can be looked back later, so it would be more enjoyable and meaningful. These tags are prepared for helping to bring up memories when photographed.

4.6.6.8.2. Temperature

Temperature as the ambient situation at the shot, for example the room temperature where the photographer was holding the camera. The unit is °C. If the denominator of the recorded value is FFFFFFFF.H, unknown shall be indicated. Obtaining method or accuracy is not stipulated. Therefore methods like that the photographer manually input the numeric, as an example, are usable.

Tag = 37888 (9400.H)
Type = SRATIONAL
Count = 1
Default = None

4.6.6.8.3. Humidity

Humidity as the ambient situation at the shot, for example the room humidity where the photographer was holding the camera. The unit is %. If the denominator of the recorded value is FFFFFFFF.H, unknown shall be indicated. Obtaining method or accuracy is not stipulated. Therefore methods like that the photographer manually input the numeric, as an example, are usable.

Tag = 37889 (9401.H
Type = RATIONAL
Count = 1
Default = None

4.6.6.8.4. Pressure

Pressure as the ambient situation at the shot, for example the room atmospfere where the photographer was holding the camera or the water pressure under the sea. The unit is hPa. If the denominator of the recorded value is FFFFFFFF.H, unknown shall be indicated. Obtaining method or accuracy is not stipulated. Therefore methods like that the photographer manually input the numeric, as an example, are usable.

Tag = 37890 (9402.H)
Type = RATIONAL
Count = 1
Default = None

4.6.6.8.5. WaterDepth

Water depth as the ambient situation at the shot, for example the water depth of the camera at underwater photography. The unit is m. When the value is negative, the absolute value of it indicates the height (elevation) above the water level. If the denominator of the recorded value is FFFFFFFF.H, unknown shall be indicated. Obtaining method or accuracy is not stipulated. Therefore methods like that the photographer manually input the numeric, as an example, are usable.

Tag = 37891 (9403.H)
Type = SRATIONAL
Count = 1
Default = None

4.6.6.8.6. Acceleration

Acceleration (a scalar regardless of direction) as the ambient situation at the shot, for example the driving acceleration of the vehicle which the photographer rode on at the shot. The unit is mGal (10^{-5} m/s^2). If the denominator of the recorded value is FFFFFFFF.H, unknown shall be indicated. Obtaining method or accuracy is not stipulated. Therefore methods like that the photographer manually input the numeric, as an example, are usable.

Tag = 37892 (9404.H)
Type = RATIONAL
Count = 1
Default = None

4.6.6.8.7. CameraElevationAngle

Elevation/depression angle of the orientation of the camera(imaging optical axis) as the ambient situation at the shot. The unit is degree(°). The range of the value is from -180 to less than 180. If the denominator of the recorded value is FFFFFFFF.H, unknown shall be indicated. Obtaining method or accuracy is not stipulated. Therefore methods like that the photographer manually input the numeric, as an example, are usable.

Tag = 37893 (9405.H)
Type = SRATIONAL
Count = 1
Default = None

4.6.6.9. I. Other tags

4.6.6.9.1. ImageUniqueID

This tag indicates an identifier assigned uniquely to each image. It shall be recorded as an ASCII stringin hexadecimal notation equivalent to 128-bit fixed length UUID compliant with ISO/IEC 9834-8. The UUID shall be UUID Version 1 or Version 4, and UUID Version 4 is recommended. This ID shall be assigned at the time of shooting image, and the recorded ID shall not be updated or erased by any subsequent editing.

Tag = 42016 (A420.H)
Type = ASCII
Count = 33
Default = None

4.6.6.9.2. CameraOwnerName

This tag records the owner of a camera used in photography as an ASCII or UTF-8 string. In principle, this tag shall not be rewritten. If there is more than one owner, such as in case of joint ownership, the name of the main owner or the name of the organization shall be listed. When the field is left blank, it is treated as unknown.

2-byte or larger character codes can not be used when ASCII is set as Type. When a 2-byte or larger code is necessary, UTF-8 shall be set as Type. The count is the value including NULL terminations.

If this tag is recorded, the Artist tag shall also be recorded.

Tag = 42032 (A430.H)
Type = ASCII or UTF-8
Count = Any
Default = None

4.6.6.9.3. BodySerialNumber

This tag records the serial number of the body of the camera that was used in photography as an ASCII string.

Tag = 42033 (A431.H)
Type = ASCII
Count = Any
Default = None

4.6.6.9.4. LensSpecification

This tag notes minimum focal length, maximum focal length, minimum F number in the minimum focal length, and minimum F number in the maximum focal length, which are specification information for the lens that was used in photography. When the minimum F number is unknown, the notation is 0/0.

Tag = 42034 (A432.H)
Type = RATIONAL
Count = 4
Default = None

Value 1 : Minimum focal length (unit: mm)
Value 2 : Maximum focal length (unit: mm)
Value 3 : Minimum F number in the minimum focal length
Value 4 : Minimum F number in the maximum focal length

4.6.6.9.5. LensMake

This tag records the lens manufacturer as an ASCII or UTF-8 string.

Tag = 42035 (A433.H)
Type = ASCII or UTF-8
Count = Any
Default = None

4.6.6.9.6. LensModel

This tag records the lens's model name and model number as an ASCII or UTF-8 string.

Tag = 42036 (A434.H)
Type = ASCII or UTF-8
Count = Any
Default = None

4.6.6.9.7. LensSerialNumber

This tag records the serial number of the interchangeable lens that was used in photography as an ASCII string.

Tag = 42037 (A435.H)
Type = ASCII
Count = Any
Default = None

4.6.6.9.8. ImageTitle

This tag records the title of the image. When the field is left blank, it is treated as unknown.

Tag = 42038 (A436.H)
Type = ASCII or UTF-8
Count = Any
Default = None

4.6.6.9.9. Photographer

This tag records the name of the photographer and, in principle, this tag shall not be rewritten. The detailed format is not specified. When the field is left blank, it is treated as unknown.

If this tag is recorded, the Artist tag shall also be recorded.

Tag = 42039 (A437.H)
Type = ASCII or UTF-8
Count = Any
Default = None

4.6.6.9.10. ImageEditor

This tag records the name of the main person who edited the image. Preferably, a single name is written (individual name, group/organization name, etc.), but multiple main editors may be entered.

The detailed format is not specified. When the field is left blank, it is treated as unknown.

If this tag is recorded, the Artist tag shall also be recorded.

Tag = 42040 (A438.H)
Type = ASCII or UTF-8
Count = Any
Default = None

4.6.6.9.11. CameraFirmware

This tag records the name and version of the software or firmware of the camera used to generate the image and, in principle, shall not be overwritten. The detailed format is not specified, but a clear description such as in the example shown below is recommended. When the field is left blank, it is treated as unknown.

If this tag is recorded, the Software tag shall also be recorded.

Ex.) “Exif Software Version 1.00a”

Tag = 42041 (A439.H)
Type = ASCII or TF-8
Count = Any
Default = None

4.6.6.9.12. RAWDevelopingSoftware

This tag records the name and version of the software used to develop the RAW image and, in principle, shall not be overwritten. The detailed format is not specified, but a clear description as in the example shown below is recommended. When the field is left blank, it is treated as unknown.

If this tag is recorded, the Software tag shall also be recorded.

Ex.) "RAW Developer Version 1.00a"

Tag = 42042 (A43A.H)
Type = ASCII or UTF-8
Count = Any
Default = None

4.6.6.9.13. ImageEditingSoftware

This tag records the name and version of the main software used for processing and editing the image. Preferably, a single software is written, but multiple main software may be entered. The detailed format is not specified, but a clear description as in the example shown below is recommended. When the field is left blank, it is treated as unknown.

If this tag is recorded, the Software tag shall also be recorded.

Ex.) "Simple Image Editor Version 1.00a"

Tag = 42043 (A43B.H)
Type = ASCII or UTF-8
Count = Any
Default = None

4.6.6.9.14. MetadataEditingSoftware

This tag records the name and version of one software used to edit the metadata of the image without processing or editing of the image data itself. The detailed format is not specified, but a clear description as in the example shown below is recommended. When the field is left blank, it is treated as unknown.

If this tag is recorded, the Software tag shall also be recorded.

Ex.) "Exif Metadata Editor Version 1.00a"

Tag = 42044 (A43C.H)
Type = ASCII or UTF-8
Count = Any
Default = None

4.6.7. GPS Attribute Information

The attribute information (field names and codes) recorded in the GPS Info IFD is given in Table 14, followed by an explanation of the contents.

The tags shown in this section were originally defined based on the GPS system, but may also be used for information obtained from Global Navigation Satellite Systems (GNSS) and other positional information systems and services (mobile phone base stations, etc.). Note that the tag names are still prefexxed with "GPS" as originally defined.

Table 14 GPS Attribute Information

Tag Name	Field Name	Tag ID		Type	Count
		Dec	Hex		
A. Tags Relating to GPS					
GPS tag version	GPSVersionID	0	0	BYTE	4
North or South Latitude	GPSLatitudeRef	1	1	ASCII	2
Latitude	GPSLatitude	2	2	RATIONAL	3
East or West Longitude	GPSLongitudeRef	3	3	ASCII	2
Longitude	GPSLongitude	4	4	RATIONAL	3
Altitude reference	GPSAltitudeRef	5	5	BYTE	1
Altitude	GPSAltitude	6	6	RATIONAL	1
GPS time (atomic clock)	GPSTimeStamp	7	7	RATIONAL	3
GPS satellites used for measurement	GPSSatellites	8	8	ASCII	Any
GPS receiver status	GPSStatus	9	9	ASCII	2
GPS measurement mode	GPSMeasureMode	10	A	ASCII	2
Measurement precision	GPSDOP	11	B	RATIONAL	1
Speed unit	GPSSpeedRef	12	C	ASCII	2
Speed of GPS receiver	GPSSpeed	13	D	RATIONAL	1
Reference for direction of movement	GPSTrackRef	14	E	ASCII	2
Direction of movement	GPSTrack	15	F	RATIONAL	1
Reference for direction of image	GPSImgDirectionRef	16	10	ASCII	2
Direction of image	GPSImgDirection	17	11	RATIONAL	1
Geodetic survey data used	GPSMapDatum	18	12	ASCII	Any
Reference for latitude of destination	GPSDestLatitudeRef	19	13	ASCII	2
Latitude of destination	GPSDestLatitude	20	14	RATIONAL	3
Reference for longitude of destination	GPSDestLongitudeRef	21	15	ASCII	2
Longitude of destination	GPSDestLongitude	22	16	RATIONAL	3
Reference for bearing of destination	GPSDestBearingRef	23	17	ASCII	2
Bearing of destination	GPSDestBearing	24	18	RATIONAL	1

	Reference for distance to destination	GPSDestDistanceRef	25	19	ASCII	2
	Distance to destination	GPSDestDistance	26	1A	RATIONAL	1
	Name of GPS processing method	GPSProcessingMethod	27	1B	UNDEFINED	Any
	Name of GPS area	GPSAreaInformation	28	1C	UNDEFINED	Any
	GPS date	GPSDateStamp	29	1D	ASCII	11
	GPS differential correction	GPSDifferential	30	1E	SHORT	1
	Horizontal positioning error	GPSHPositioningError	31	1F	RATIONAL	1

Note The position information of the subject of the photograph can be described in Annotation Data.

4.6.7.1. A. Tags Relating to GPS

4.6.7.1.1. GPSVersionID

Indicates the version of GPSInfoIFD. The version is given as 2.4.0.0. This tag is mandatory when at least one tag related to the GPS is present. Note that the GPSVersionID tag is written as a different byte than the ExifVersion tag.

Tag = 0 (0.H)
Type = BYTE
Count = 4
Default = 2.4.0.0

2.4.0.0 = Version 2.4
Other = reserved

4.6.7.1.2. GPSLatitudeRef

Indicates whether the latitude of shooting location is north or south latitude. 'N' indicates north latitude, and 'S' is south latitude.

Tag = 1 (1.H)
Type = ASCII
Count = 2
Default = None

'N' = North latitude
'S' = South latitude
Other = reserved

4.6.7.1.3. GPSLatitude

Indicates the latitude of shooting location. The latitude is expressed as three RATIONAL values giving the degrees, minutes, and seconds, respectively. If latitude is expressed as degrees, minutes and seconds, a typical format would be dd/1, mm/1, ss/1. When degrees and minutes are used and, for example, fractions of minutes are given up to two decimal places, the format would be dd/1, mmmm/100, 0/1.

Tag = 2 (2.H)
Type = RATIONAL
Count = 3
Default = None

4.6.7.1.4. GPSLongitudeRef

Indicates whether the longitude of shooting location is east or west longitude. 'E' indicates east longitude, and 'W' is west longitude.

Tag = 3 (3.H)
Type = ASCII
Count = 2
Default = None

'E' = East longitude
'W' = West longitude
Other = reserved

4.6.7.1.5. GPSLongitude

Indicates the longitude of shooting location. The longitude is expressed as three RATIONAL values giving the degrees, minutes, and seconds, respectively. If longitude is expressed as degrees, minutes and seconds, a typical format would be ddd/1, mm/1, ss/1. When degrees and minutes are used and, for example, fractions of minutes are given up to two decimal places, the format would be ddd/1, mmmm/100, 0/1.

Tag = 4 (4.H)
Type = RATIONAL
Count = 3
Default = None

4.6.7.1.6. GPSAltitudeRef

Indicates the altitude of shooting location used as the reference altitude. The reference is an ellipsoidal surface. 0 is recorded if the altitude is at or above the ellipsoidal surface (positive value), and 1 is recorded if the altitude is below the ellipsoidal surface (negative value).

Sea level may also be used as a reference. 2 is recorded if the altitude is at or above sea level (positive value), and 3 is recorded if the altitude is below sea level (negative value).

Based on the reference specified in this tag, the absolute value of the altitude is recorded in the GPSAltitude tag.

The reference unit is meters. Note that this tag is BYTE type, unlike other reference tags.

Tag = 5 (5.H)
Type = BYTE
Count = 1
Default = 0

0 = Positive ellipsoidal height (at or above ellipsoidal surface)
1 = Negative ellipsoidal height (below ellipsoidal surface)
2 = Positive sea level value (at or above sea level reference)
3 = Negative sea level value (below sea level reference)
Other = reserved

4.6.7.1.7. GPSAltitude

Indicates the altitude of shooting location based on the reference in GPSAltitudeRef. The altitude indicates the ellipsoidal height or sea level height and is expressed as one RATIONAL value.

The reference unit is meters.

Tag = 6 (6.H)
Type = RATIONAL
Count = 1
Default = None

4.6.7.1.8. GPSTimeStamp

Indicates the reference time (atomic clock time) obtained by the GPS receiver and is recorded in UTC (Coordinated Universal Time). Time Stamp is expressed as three RATIONAL values giving the hours, minutes, and seconds.

The date information (day, month, year) is recorded in the GPSDateStamp tag.

Tag = 7 (7.H)
Type = RATIONAL
Count = 3
Default = None

4.6.7.1.9. GPSSatellites

Indicates the GPS satellites used for measurements. This tag may be used to describe the number of satellites, their ID number, angle of elevation, azimuth, SNR and other information in ASCII notation. The format is not specified. If the GPS receiver is incapable of taking measurements, value of the tag shall be set to NULL.

Tag = 8 (8.H)
Type = ASCII
Count = Any
Default = None

4.6.7.1.10. GPSStatus

Indicates the status of the GPS receiver when the image is recorded. 'A' means measurement is in progress, and 'V' means the measurement is interrupted.

Tag = 9 (9.H)
Type = ASCII
Count = 2
Default = None

'A' = Measurement in progress

'V' = Measurement interrupted

Other = reserved

4.6.7.1.11. GPSMeasureMode

Indicates the GPS measurement mode. The value '2' shall be recorded in case of two-dimensional measurement (latitude and longitude only) and the value '3' shall be recorded in case of three-dimensional measurement (latitude, longitude, and altitude).

Tag = 10 (A.H)
Type = ASCII
Count = 2
Default = None

'2' = 2-dimensional measurement

'3' = 3-dimensional measurement

Other = reserved

4.6.7.1.12. GPSDOP

Indicates the GPS DOP (data degree of precision). An HDOP value is written during two-dimensional measurement, and PDOP during three-dimensional measurement.

Tag = 11 (B.H)
Type = RATIONAL
Count = 1
Default = None

4.6.7.1.13. GPSSpeedRef

Indicates the unit used to express the GPS receiver speed of movement. 'K' 'M' and 'N' represents kilometers per hour, miles per hour, and knots.

Tag = 12 (C.H)
Type = ASCII
Count = 2
Default = 'K'

'K' = Kilometers per hour

'M' = Miles per hour

'N' = Knots

Other = reserved

4.6.7.1.14. GPSSpeed

Indicates the speed of GPS receiver movement.

If the acceleration is acquirable, the value can be written in the Acceleration tag, making it possible to indicate movement related information in more detail.

Tag = 13 (D.H)
Type = RATIONAL
Count = 1
Default = None

4.6.7.1.15. GPSTrackRef

Indicates the reference for giving the direction of GPS receiver movement. 'T' denotes true direction and 'M' is magnetic direction.

Tag = 14 (E.H)
Type = ASCII
Count = 2
Default = 'T'

'T' = True direction

'M' = Magnetic direction

Other = reserved

4.6.7.1.16. GPSTrack

Indicates the direction of GPS receiver movement. The range of values is from 0.00 to 359.99.

Tag = 15 (F.H)
Type = RATIONAL
Count = 1
Default = None

4.6.7.1.17. GPSImgDirectionRef

Indicates the reference for giving the direction of the image when it is captured. 'T' denotes true direction and 'M' is magnetic direction.

Tag = 16 (10.H)
Type = ASCII
Count = 2
Default = 'T'

'T' = True direction
'M' = Magnetic direction
Other = reserved

4.6.7.1.18. GPSImgDirection

Indicates the direction of the image when it was captured. The range of values is from 0.00 to 359.99.

If the elevation angle is acquirable, the value can be written in the CameraElevationAngle tag, making it possible to indicate the direction of the image in richer detail.

Tag = 17 (11.H)
Type = RATIONAL
Count = 1
Default = None

4.6.7.1.19. GPSMapDatum

Indicates the geodetic survey data used by the GPS receiver. If the survey data is restricted to Japan,the value of this tag is 'TOKYO' or 'WGS-84'. If a GPS Attribute Infromation tag is recorded, it is strongly recommended that this tag be recorded.

Tag = 18 (12.H)
Type = ASCII
Count = Any
Default = None

4.6.7.1.20. GPSDestLatitudeRef

Indicates whether the latitude of the destination point is north or south latitude. 'N' indicates north latitude, and 'S' is south latitude.

Tag = 19 (13.H)
Type = ASCII
Count = 2
Default = None

'N' = North latitude
'S' = South latitude
Other = reserved

4.6.7.1.21. GPSDestLatitude

Indicates the latitude of the destination point. The latitude is expressed as three RATIONAL values giving the degrees, minutes, and seconds, respectively. If latitude is expressed as degrees, minutes and seconds, a typical format would be dd/1, mm/1, ss/1. When degrees and minutes are used and, for example, fractions of minutes are given up to two decimal places, the format would be dd/1, mmmm/100, 0/1.

Tag = 20 (14.H)
Type = RATIONAL
Count = 3
Default = None

4.6.7.1.22. GPSDestLongitudeRef

Indicates whether the longitude of the destination point is east or west longitude. 'E' indicates east longitude, and 'W' is west longitude.

Tag = 21 (15.H)
Type = ASCII
Count = 2
Default = None

'E' = East longitude
'W' = West longitude
Other = reserved

4.6.7.1.23. GPSDestLongitude

Indicates the longitude of the destination point. The longitude is expressed as three RATIONAL values giving the degrees, minutes, and seconds, respectively. If longitude is expressed as degrees, minutes and seconds, a typical format would be ddd/1, mm/1, ss/1. When degrees and minutes are used and, for example, fractions of minutes are given up to two decimal places, the format would be ddd/1, mmmm/100, 0/1.

Tag = 22 (16.H)
Type = RATIONAL
Count = 3
Default = None

4.6.7.1.24. GPSDestBearingRef

Indicates the reference used for giving the bearing to the destination point. 'T' denotes true direction and 'M' is magnetic direction.

Tag = 23 (17.H)
Type = ASCII
Count = 2
Default = 'T'

'T' = True direction

'M' = Magnetic direction

Other = reserved

4.6.7.1.25. GPSDestBearing

Indicates the bearing to the destination point. The range of values is from 0.00 to 359.99.

Tag = 24 (18.H)
Type = RATIONAL
Count = 1
Default = None

4.6.7.1.26. GPSDestDistanceRef

Indicates the unit used to express the distance to the destination point. 'K', 'M' and 'N' represent kilometers, miles and nautical miles .

Tag = 25 (19.H)
Type = ASCII
Count = 2
Default = 'K'

'K' = Kilometers

'M' = Miles

'N' = Nautical miles

Other = reserved

4.6.7.1.27. GPSDestDistance

Indicates the distance to the destination point.

Tag = 26 (1A.H)
Type = RATIONAL
Count = 1
Default = None

4.6.7.1.28. GPSProcessingMethod

A character string recording the name of the method used for location finding. The value is a multicode-compatible string and shall be entered in a form along with an character identifier code to identify the character code to be used. See section 4.6.4 for details on the form.

Since the Type is not ASCII, NULL termination is not necessary.

Tag = 27 (1B.H)
Type = UNDEFINED
Count = Any
Default = None

Although this tag was originally defined for GPS use, it may record positional information obtained from GNSS system other than GPS, mobile phone base stations and wireless LAN in addition to GPS. When recording information that was gathered using the GPS and other various positioning methods, this tag and related tags may be used as shown in Table 15 below.

Table 15 Setting of each positioning method

Positioning Method	GPSProcessingMethod Tag	GPSMeasureMode Tag
GPS	“GPS”	'2' or '3'
Quasi-Zenith Satellite System (QZSS)	“QZSS”	'2' or '3'
Galileo	“GALILEO”	'2' or '3'
GLONASS	“GLONASS”	'2' or '3'
BeiDou Navigation Satellite System	“BEIDOU”	'2' or '3'
Navigation Indian Constellation (NavIC)	“NAVIC”	'2' or '3'
mobile phone base station (cell-id)	“CELLID”	Generally '2'
wireless LAN	“WLAN”	Generally '2'
entered manually	“MANUAL”	Not recorded

When more than one of the above methods are used to calculate positional information (hybrid method, multi-GNSS):

a) The used methods are listed with a space between the strings indicating each method in the GPSProcessingMethod tag. The method contributing the most is listed first.

b) GThe measurement mode contributing most to the calculation of positional information is recorded in GPSMeasureMode.

4.6.7.1.29. GPSAreaInformation

A character string recording the name of the GPS area. This is a multicode-compatible string and shall be entered in a form along with an character identifier code to identify the character code to be used. See section 4.6.4 for details on the form. Since the Type is not ASCII, NULL termination is not necessary.

Tag = 28 (1C.H)
Type = UNDEFINED
Count = Any
Default = None

4.6.7.1.30. GPSDateStamp

Indicates recording date and time information based on reference time (atomic clock time) obtained by the GPS receiver in UTC (Coordinated Universal Time). The format is "YYYY:MM:DD."

The time information (hour, minute, second) is recorded in the GPSTimeStamp tag.

Tag = 29 (1D.H)
Type = ASCII
Count = 11
Default = None

4.6.7.1.31. GPSDifferential

Indicates whether differential correction is applied to the GPS receiver.

Tag = 30 (1E.H)
Type = SHORT
Count = 1
Default = None

0 = Measurement without differential correction
1 = Differential correction applied
Other = reserved

4.6.7.1.32. GPSHPositioningError

This tag indicates horizontal positioning errors in meters.

Tag = 31 (1F.H)
Type = RATIONAL
Count = 1
Default = None

4.6.8. Interoperability IFD Attribute Information

The attached information(field name, code) stored in Interoperability IFD is listed in Table 16. The meaning is explained below.

Table 16 Interoperability IFD Attribute Information

Tag Name	Field Name	Tag ID		Type	Count
		Dec	Hex		
A. Attached Information Related to Interoperability					
Interoperability Identification	InteroperabilityIndex	1	1	ASCII	Any

4.6.8.1. A. Tags Relating to Interoperability

The rules for Exif image files defines the description of the following tag. Other tags stored in Interoperability IFD may be defined dependently to each interoperability rule.

4.6.8.1.1. InteroperabilityIndex

Indicates the identification of the Interoperability rule. The following rules are defined. Four Bytes used including the termination code (NULL).

Tag = 1 (1.H)
Type = ASCII
Count = Any
Default = None

"R98" = Indicates a file conforming to R98 file stipulated by ExifR98[1] or to DCF basic file stipulated by Design Rule for Camera File System[2].

"THM" = Indicates a file conforming to DCF thumbnail file stipulated by Design rule for Camera File System[2].

“R03” = Indicates a file conforming to DCF Option File stipulated by Design rule for Camera File System[2].

4.6.9. Tag Support Levels

The tags and their support levels are given here.

4.6.9.1. Primary Image (0th IFD) Support Levels

The support levels of primary image (0th IFD) tags are given in Table 17, Table 18,Table 19 and Table 20.

Table 17 Tag Support Levels (1) - 0th IFD TIFF Tags –

Tag Name	Field Name	Tag ID		Uncompressed			Compressed
		Dec	Hex	Chunky	Planar	YCC	
Image width	ImageWidth	256	100	M	M	M	J
Image height	ImageLength	257	101	M	M	M	J
Number of bits per component	BitsPerSample	258	102	M	M	M	J
Compression scheme	Compression	259	103	M	M	M	J
Pixel composition	PhotometricInterpretation	262	106	M	M	M	N
Description of Image	ImageDescription	270	10E	R	R	R	R
Manufacturer of image input equipment	Make	271	10F	R	R	R	R
Model of image input equipment	Model	272	110	R	R	R	R
Offset of strip	StripOffsets	273	111	M	M	M	N
Orientation of image	Orientation	274	112	R	R	R	R
Number of components	SamplesPerPixel	277	115	M	M	M	J
Number of rows per strip	RowsPerStrip	278	116	M	M	M	N
Bytes per compressed strip	StripByteCounts	279	117	M	M	M	N
Image resolution in width direction	XResolution	282	11A	O	O	O	O

Image resolution in height direction	YResolution	283	11B	O	O	O	O
Image data arrangement	PlanarConfiguration	284	11C	O	M	O	J
Unit of X and Y resolution	ResolutionUnit	296	128	O	O	O	O
Transfer function	TransferFunction	301	12D	O	O	O	O
Software used	Software	305	131	O	O	O	O
File change date and time	DateTime	306	132	R	R	R	R
Person who created the image	Artist	315	13B	O	O	O	O
White point chromaticity	WhitePoint	318	13E	O	O	O	O
Chromaticities of primaries	PrimaryChromaticities	319	13F	O	O	O	O
Offset to JPEG SOI	JPEGInterchangeFormat	513	201	N	N	N	N
Bytes of JPEG data	JPEGInterchangeFormatLength	514	202	N	N	N	N
Color space transformation matrix coefficients	YCbCrCoefficients	529	211	N	N	O	O
Subsampling ratio of Y to C	YCbCrSubSampling	530	212	N	N	M	J
Y and C positioning	YCbCrPositioning	531	213	N	N	M	M
Pair of black and white reference values	ReferenceBlackWhite	532	214	O	O	O	O
Copyright holder	Copyright	33432	8298	O	O	O	O
Pointer to Exif IFD	Exif IFD Pointer	34665	8769	M	M	M	M
Pointer to GPS Info IFD	GPSInfo IFD Pointer	34853	8825	O	O	O	O

Notation

M : Mandatory (shall be recorded)
R : Recommended
O : Optional
N : It is not allowed to record
J : It is not allowed to record (included in JPEG marker)

Table 18 Tag Support Levels (2) - 0th IFD Exif Private Tags –

Tag Name	Field Name	Tag ID		Uncompressed			Compressed
		Dec	Hex	Chunky	Planar	YCC	
Exposure time	ExposureTime	33434	829A	R	R	R	R
F number	FNumber	33437	829D	O	O	O	O
Exposure program	ExposureProgram	34850	8822	O	O	O	O
Spectral sensitivity	SpectralSensitivity	34852	8824	O	O	O	O
Photographic Sensitivity	PhotographicSensitivity	34855	8827	O	O	O	O
Optoelectric coefficient	OECF	34856	8828	O	O	O	O
Sensitivity Type	SensitivityType	34864	8830	O	O	O	O
Standard Output Sensitivity	StandardOutputSensitivity	34865	8831	O	O	O	O
Recommended Exposure Index	RecommendedExposureIndex	34866	8832	O	O	O	O
ISOSpeed	ISOSpeed	34867	8833	O	O	O	O

ISOSpeed Latitude yyy	ISOSpeedLatitudeyyy	34868	8834	O	O	O	O
ISOSpeed Latitude zzz	ISOSpeedLatitudezzz	34869	8835	O	O	O	O
Exif Version	ExifVersion	36864	9000	M	M	M	M
Date and time original image was generated	DateTimeOriginal	36867	9003	O	O	O	O
Date and time image was made digital data	DateTimeDigitized	36868	9004	O	O	O	O
Offset data of DateTime	OffsetTime	36880	9010	O	O	O	O
Offset data of DateTimeOriginal	OffsetTimeOriginal	36881	9011	O	O	O	O
Offset data of DateTimeDigitized	OffsetTimeDigitized	36882	9012	O	O	O	O
Meaning of each component	ComponentsConfiguration	37121	9101	N	N	N	M
Image compression mode	CompressedBitsPerPixel	37122	9102	N	N	N	O
Shutter speed	ShutterSpeedValue	37377	9201	O	O	O	O
Aperture	ApertureValue	37378	9202	O	O	O	O
Brightness	BrightnessValue	37379	9203	O	O	O	O
Exposure bias	ExposureBiasValue	37380	9204	O	O	O	O
Maximum lens aperture	MaxApertureValue	37381	9205	O	O	O	O
Subject distance	SubjectDistance	37382	9206	O	O	O	O
Metering mode	MeteringMode	37383	9207	O	O	O	O
Light source	LightSource	37384	9208	O	O	O	O
Flash	Flash	37385	9209	R	R	R	R
Lens focal length	FocalLength	37386	920A	O	O	O	O
Subject area	SubjectArea	37396	9214	O	O	O	O
Manufacturer notes	MakerNote	37500	927C	O	O	O	O
User comments	UserComment	37510	9286	O	O	O	O
DateTime sub-seconds	SubSecTime	37520	9290	O	O	O	O
DateTimeOriginal sub-seconds	SubSecTimeOriginal	37521	9291	O	O	O	O
DateTimeDigitized sub-seconds	SubSecTimeDigitized	37522	9292	O	O	O	O
Temperature	Temperature	37888	9400	O	O	O	O
Humidity	Humidity	37889	9401	O	O	O	O
Pressure	Pressure	37890	9402	O	O	O	O
WaterDepth	WaterDepth	37891	9403	O	O	O	O
Acceleration	Acceleration	37892	9404	O	O	O	O
Camera elevation angle	CameraElevationAngle	37893	9405	O	O	O	O
Tiele name of Image	ImageTitle	42038	A436	O	O	O	O
Photographer name	Photographer	42039	A437	O	O	O	O
Person who edited the image	ImageEditor	42040	A438	O	O	O	O
Camera Firmware	CameraFirmware	42041	A439	O	O	O	O

RAW Developing Software	RAWDevelopingSoftware	42042	A43A	O	O	O	O
Image Editing Software	ImageEditingSoftware	42043	A43B	O	O	O	O
Metadata Editing Software	MetadataEditingSoftware	42044	A43C	O	O	O	O
Supported Flashpix version	FlashpixVersion	40960	A000	O	O	O	O
Color space information	ColorSpace	40961	A001	M	M	M	M
Valid image width	PixelXDimension	40962	A002	N	N	N	M
Valid image height	PixelYDimension	40963	A003	N	N	N	M
Related audio file	RelatedSoundFile	40964	A004	O	O	O	O
Interoperability tag	Interoperability IFD Pointer	40965	A005	N	N	N	O
Flash energy	FlashEnergy	41483	A20B	O	O	O	O
Spatial frequency response	SpatialFrequencyResponse	41484	A20C	O	O	O	O
Focal plane X resolution	FocalPlaneXResolution	41486	A20E	O	O	O	O
Focal plane Y resolution	FocalPlaneYResolution	41487	A20F	O	O	O	O
Focal plane resolution unit	FocalPlaneResolutionUnit	41488	A210	O	O	O	O
Subject location	SubjectLocation	41492	A214	O	O	O	O
Exposure index	ExposureIndex	41493	A215	O	O	O	O
Sensing method	SensingMethod	41495	A217	O	O	O	O
File source	FileSource	41728	A300	O	O	O	O
Scene type	SceneType	41729	A301	O	O	O	O
CFA pattern	CFAPattern	41730	A302	O	O	O	O
Custom image processing	CustomRendered	41985	A401	O	O	O	O
Exposure mode	ExposureMode	41986	A402	R	R	R	R
White balance	WhiteBalance	41987	A403	R	R	R	R
Digital zoom ratio	DigitalZoomRatio	41988	A404	O	O	O	O
Focal length in 35 mm film	FocalLengthIn35mmFilm	41989	A405	O	O	O	O
Scene capture type	SceneCaptureType	41990	A406	R	R	R	R
Gain control	GainControl	41991	A407	O	O	O	O
Contrast	Contrast	41992	A408	O	O	O	O
Saturation	Saturation	41993	A409	O	O	O	O
Sharpness	Sharpness	41994	A40A	O	O	O	O
Device settings description	DeviceSettingDescription	41995	A40B	O	O	O	O
Subject distance range	SubjectDistanceRange	41996	A40C	O	O	O	O
Unique image ID	ImageUniqueID	42016	A420	O	O	O	O
Camera Owner Name	CameraOwnerName	42032	A430	O	O	O	O
BodySerial Number	BodySerialNumber	42033	A431	O	O	O	O
Lens Specification	LensSpecification	42034	A432	O	O	O	O

Lens Make	LensMake	42035	A433	O	O	O	O
Lens Model	LensModel	42036	A434	O	O	O	O
Lens Serial Number	LensSerialNumber	42037	A435	O	O	O	O
Composite image	CompositeImage	42080	A460	R	R	R	R
Source image number of composite image	SourceImageNumberOfCompositeImage	42081	A461	O	O	O	O
Source exposure times of composite image	SourceExposureTimesOfCompositeImage	42082	A462	O	O	O	O
Gamma	Gamma	42240	A500	O	O	O	O

Notation

M	:	Mandatory (shall be recorded)
R	:	Recommended
O	:	Optional
N	:	It is not allowed to record
J	:	It is not allowed to record (included in JPEG marker)

Table 19 Tag Support Levels (3) - 0th IFD GPS Info Tags -

Tag Name	Field Name	Tag ID		Uncompressed			Compressed
		Dec	Hex	Chunky	Planar	YCC	
GPS tag version	GPSVersionID	0	0	O	O	O	O
North or South Latitude	GPSLatitudeRef	1	1	O	O	O	O
Latitude	GPSLatitude	2	2	O	O	O	O
East or West Longitude	GPSLongitudeRef	3	3	O	O	O	O
Longitude	GPSLongitude	4	4	O	O	O	O
Altitude reference	GPSAltitudeRef	5	5	O	O	O	O
Altitude	GPSAltitude	6	6	O	O	O	O
GPS time (atomic clock)	GPSTimeStamp	7	7	O	O	O	O
GPS satellites used for measurement	GPSSatellites	8	8	O	O	O	O
GPS receiver status	GPSStatus	9	9	O	O	O	O
GPS measurement mode	GPSMeasureMode	10	A	O	O	O	O
Measurement precision	GPSDOP	11	B	O	O	O	O
Speed unit	GPSSpeedRef	12	C	O	O	O	O
Speed of GPS receiver	GPSSpeed	13	D	O	O	O	O
Reference for direction of movement	GPSTrackRef	14	E	O	O	O	O
Direction of movement	GPSTrack	15	F	O	O	O	O
Reference for direction of image	GPSImgDirectionRef	16	10	O	O	O	O
Reference for direction of image	GPSImgDirectionRef	16	10	O	O	O	O
Direction of image	GPSImgDirection	17	11	O	O	O	O
Geodetic survey data used	GPSMapDatum	18	12	O	O	O	O
Reference for latitude of destination	GPSDestLatitudeRef	19	13	O	O	O	O

Latitude of destination	GPSDestLatitude	20	14	O	O	O	O
Reference for longitude of destination	GPSDestLongitudeRef	21	15	O	O	O	O
Longitude of destination	GPSDestLongitude	22	16	O	O	O	O
Reference for bearing of destination	GPSDestBearingRef	23	17	O	O	O	O
Bearing of destination	GPSDestBearing	24	18	O	O	O	O
Reference for distance to destination	GPSDestDistanceRef	25	19	O	O	O	O
Distance to destination	GPSDestDistance	26	1A	O	O	O	O
Name of GPS processing method	GPSProcessingMethod	27	1B	O	O	O	O
Name of GPS area	GPSAreaInformation	28	1C	O	O	O	O
GPS date	GPSDateStamp	29	1D	O	O	O	O
GPS differential correction	GPSDifferential	30	1E	O	O	O	O
Horizontal positioning error	GPSHPositioningError	31	1F	O	O	O	O

Notation

M : Mandatory (shall be recorded)
R : Recommended
O : Optional
N : It is not allowed to record
J : It is not allowed to record (included in JPEG marker)

Table 20 Tag Support Levels (4) - 0th IFD Interoperability Tag –

Tag Name	Field Name	Tag ID		Uncompressed			Compressed
		Dec	Hex	Chunky	Planar	YCC	
Interoperability Identification	InteroperabilityIndex	1	1	N	N	N	O

Notation

M : Mandatory (shall be recorded)
R : Recommended
O : Optional
N : It is not allowed to record
J : It is not allowed to record (included in JPEG marker)

4.6.9.2. Thumbnail (1st IFD) Support Levels

The support levels of thumbnail (1st IFD) tags are shown in Table 21.

Table 21 Tag Support Levels (5) - 1st IFD TIFF Tag -

Tag Name	Field Name	Tag ID		Uncompressed			Compressed
		Dec	Hex	Chunky	Planar	YCC	
Image width	ImageWidth	256	100	M	M	M	J
Image height	ImageLength	257	101	M	M	M	J
Number of bits per component	BitsPerSample	258	102	M	M	M	J

Compression scheme	Compression	259	103	M	M	M	M
Pixel composition	PhotometricInterpretation	262	106	M	M	M	J
Description of Image	ImageDescription	270	10E	O	O	O	O
Manufacturer of image input equipment	Make	271	10F	O	O	O	O
Model of image input equipment	Model	272	110	O	O	O	O
Offset of strip	StripOffsets	273	111	M	M	M	N
Orientation of image	Orientation	274	112	O	O	O	O
Number of components	SamplesPerPixel	277	115	M	M	M	J
Number of rows per strip	RowsPerStrip	278	116	M	M	M	N
Bytes per compressed strip	StripByteCounts	279	117	M	M	M	N
Image resolution in width direction	XResolution	282	11A	O	O	O	O
Image resolution in height direction	YResolution	283	11B	O	O	O	O
Image data arrangement	PlanarConfiguration	284	11C	O	M	O	J
Unit of X and Y resolution	ResolutionUnit	296	128	O	O	O	O
Transfer function	TransferFunction	301	12D	O	O	O	O
Software used	Software	305	131	O	O	O	O
File change date and time	DateTime	306	132	O	O	O	O
Person who created the image	Artist	315	13B	O	O	O	O
White point chromaticity	WhitePoint	318	13E	O	O	O	O
Chromaticities of primaries	PrimaryChromaticities	319	13F	O	O	O	O
Offset to JPEG SOI	JPEGInterchangeFormat	513	201	N	N	N	M
Bytes of JPEG data	JPEGInterchangeFormatLength	514	202	N	N	N	M
Color space transformation matrix coefficients	YCbCrCoefficients	529	211	N	N	O	O
Subsampling ratio of Y to C	YCbCrSubSampling	530	212	N	N	M	J
Y and C positioning	YCbCrPositioning	531	213	N	N	O	O
Pair of black and white reference values	ReferenceBlackWhite	532	214	O	O	O	O
Copyright holder	Copyright	33432	8298	O	O	O	O
Pointer to Exif IFD	Exif IFD Pointer	34665	8769	O	O	O	O
Pointer to GPS Info IFD	GPSInfo IFD Pointer	34853	8825	O	O	O	O

Notation

M : Mandatory (shall be recorded)
R : Recommended
O : Optional
N : It is not allowed to record
J : It is not allowed to record (included in JPEG marker)

4.7. JPEG Marker Segments Used in Exif

In addition to the compressed data (entropy coded data), a compressed file contains one each of the marker segments APP1, DQT, DHT, SOF and SOS. The compressed data begins with an SOI and ends with an EOI marker. No specification is made regarding data arrays that come after EOI. A restart marker (DRI, RSTm) may be inserted optionally. Another option is to have two or more APP2 markers. APPn other than APP1, APP2 and APP11, or COM marker are not used by Exif. However Exif/DCF readers should be designed skip over unknown APPn and COM. APP1 shall be recorded immediately after SOI, and if there is an APP2 it follows after APP1. APP11 shall be recorded, if necessary, after APP1 and APP2, and before DQT, DHT, DRI and SOF. DQT, DHT, DRI and SOF come after the last APPand before SOS, in any order.

The marker segments used in Exif are listed in Table 22.

Table 22 Marker Segments

	Marker Name	Marker Code	Description
SOI	Start of Image	FFD8.H	Start of compressed data
APP1	Application Segment 1	FFE1.H	Exif attribute information
APP2	Application Segment 2	FFE2.H	Exif extended data
APP11	Application Segment 11	FFEB.H	Annotation Data etc.
DQT	Define Quantization Table	FFDB.H	Quantization table definition
DHT	Define Huffman Table	FFC4.H	Huffman table definition
DRI	Define Restart Interval	FFDD.H	Restart Interval definition
SOF	Start of Frame	FFC0.H	Parameter data relating to frame
SOS	Start of Scan	FFDA.H	Parameters relating to components
EOI	End of Image	FFD9.H	End of compressed data

The data structures of markers defined in JPEG Baseline DCT and used in Exif compressed files, as well as the APP1, APP2 and APP11 data structures defined specifically for this standard, are explained below.

4.7.1. JPEG Marker Segments

The data structure of JPEG marker segments other than APP1. APP2 and APP11 is noted below.

4.7.1.1. Start of compressed data (SOI: Start of Image)

SOI is a marker code indicating the start of compressed data (see Figure 26).

Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	1	FF	Marker Prefix
+01	1	D8	SOI

Figure 26 SOI Structure

4.7.1.2. Quantization table definition (DQT: Define Quantization Table)

DQT is a marker code defining a quantization table.

As many as three kinds of tables may be recorded with a precision of 8 bits (Pq=0). All quantization tables shall be defined in one DQT marker segment; recording of multiple DQT markers is not allowed.

The table may have any values (see Figure 27). DQT, DHT, DRI and SOF may line up in any order, but shall be recorded after the last APP and before SOS.

Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	1	FF	Marker Prefix
+01	1	DB	DQT
+02	2	00 C5	Length of field 2+(1+64)＊3 = 197 [Byte]
+04	1	00	Y: Pq=0, Nq=0
+05	64	:	Quantization table Y: Q0
:		:	:
:		:	:
:		:	Quantization table Y: Q63
+45	1	01	Cb : Pq=0, Nq=1
+46	64	:	Quantization table Cb: Q0
:		:	:
:		:	:
:		:	Quantization table Cb: Q63
+86	1	02	Cr : Pq=0, Nq=1
+87	64	:	Quantization table Cr: Q0
:		:	:
:		:	:
:		:	Quantization table Cr: Q63

Figure 27 DQT Structure (with three quantization tables)

4.7.1.3. Huffman table definition (DHT: Define Huffman Table)

DHT is a marker code defining a Huffman table.

In this standard a single component shall have a Huffman table consisting of a set of DC and AC, and each component shall be mapped to one or another of the Huffman tables defined by DHT. All Huffman tables shall be recorded in one DHT marker segment; recording of multiple DHT markers is not allowed.

A Huffman table may have any values, or the JPEG reference values can be used as the base table (see Figure 28).

DQT, DHT, DRI and SOF may line up in any order, but shall be recorded after the last APP and before SOS.

Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	1	FF	Marker Prefix
+01	1	C4	DHT
+02	2	01 A2	Length of field 2+(1+16+12+1+16+162)∗2 = 418 [Byte]
+04	1	00	Table number Y-DC: 00
+05 : :	28		DHT parameter
+21	1	10	Table number Y-AC: 10
+22 : :	178		DHT parameter
+D4	1	01	Table number C-DC: 01
+D5 : :	28		DHT parameter
+F1	1	11	Table number C-AC: 11
+F2 : :	178		DHT parameter

Figure 28 DHT Structure

4.7.1.4. Restart Interval definition (DRI: Define Restart Interval)

DRI is a marker defining the interval at which restart markers are inserted (see Figure 29). The recording of DRI and insertion of restart markers are optional. If restart markers are inserted, DRI shall be recorded and its values shall be 4 MCU (Minimum Coding Unit), i.e., 64 pixel units, regardless of whether 4:2:2 or 4:2:0 is used for color sampling (see Annex F). Only one DRI shall be recorded.

DQT, DHT, DRI and SOF may line up in any order, but shall be recorded after the last APP and before SOS.

Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	1	FF	Marker Prefix
+01	1	DD	DRI
+02	2	00 04	Length of field 2+2 = 4 [Byte]
+04	2	00 04	Restart Insertion Interval = 4

Figure 29 DRI Structure

4.7.1.5. Frame header (SOF: Start of Frame)

SOF is a marker code indicating the start of a frame segment and giving various parameters for that frame (see Figure 30).

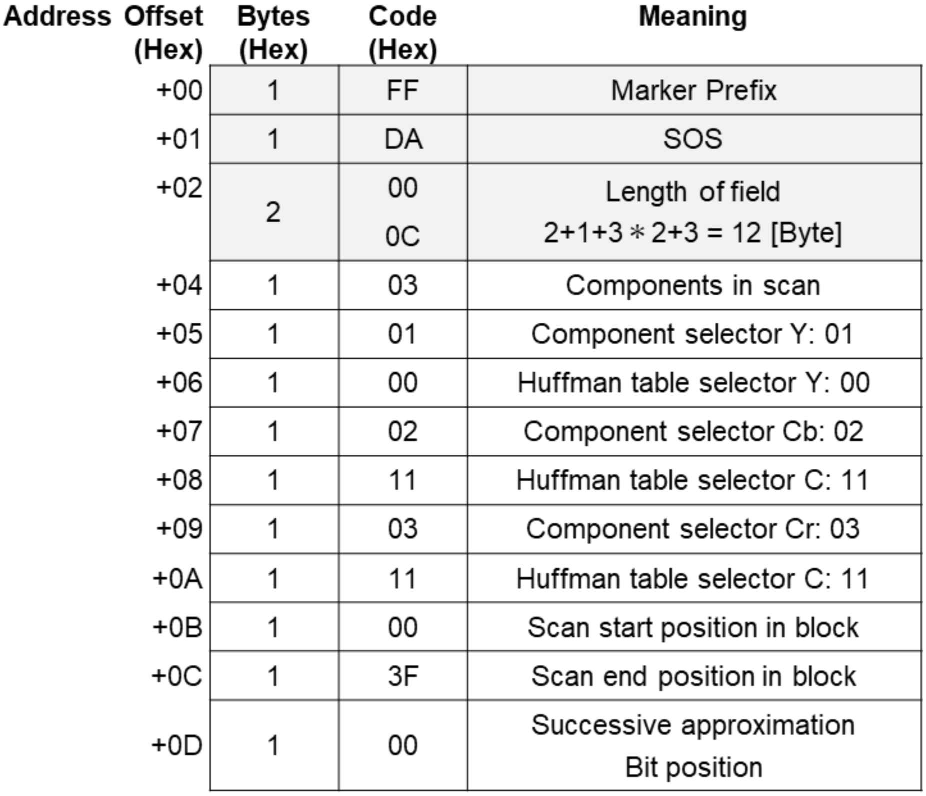
DQT, DHT, DRI and SOF may line up in any order, but shall be recorded after the last APP and before SOS.

Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	1	FF	Marker Prefix
+01	1	C0	SOF
+02	2	00 11	Length of field 2+1+2+2+1+3 ∗ 3 = 17 [Byte]
+04	1	08	Data precision [bit]
+05	2	xx yy	Vertical lines xxyy(Hex) [lines]
+07	2	ww zz	Horizontal lines wwzz(Hex) [pixels]
+09	1	03	Components
+0A	1	01	Component number (1:Y)
+0B	1	21 or 22	H0 = 2, V0 = 1(4:2:2) or 2(4:2:0)
+0C	1	00	Quantization designation
+0D	1	02	Component number (2:Cb)
+0E	1	11	H1 =1, V1 = 1
+0F	1	01	Quantization designation
+10	1	03	Component number (3:Cr)
+11	1	11	H2 =1, V2 = 1
+12	1	02	Quantization designation

Figure 30 SOF Structure

4.7.1.6. Scan header (SOS: Start of Scan)

SOS is a marker code giving various scan-related parameters (see Figure 31).



Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	1	FF	Marker Prefix
+01	1	DA	SOS
+02	2	00 0C	Length of field 2+1+3∗2+3 = 12 [Byte]
+04	1	03	Components in scan
+05	1	01	Component selector Y: 01
+06	1	00	Huffman table selector Y: 00
+07	1	02	Component selector Cb: 02
+08	1	11	Huffman table selector C: 11
+09	1	03	Component selector Cr: 03
+0A	1	11	Huffman table selector C: 11
+0B	1	00	Scan start position in block
+0C	1	3F	Scan end position in block
+0D	1	00	Successive approximation Bit position

Figure 31 SOS Structure

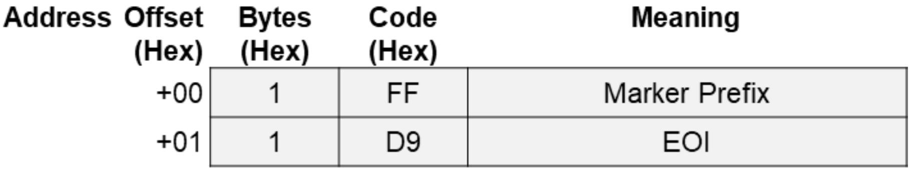
4.7.1.7. Compressed data

Compressed data is byte data block interleave at the required ratio of Y:Cb:Cr and Huffman encoded. An EOB (End of Block) is inserted in each block when the last value of its DCT coefficient is 0.

If restart marker insertion is defined in DRI, restart markers are inserted at 4 MCU interval.

4.7.1.8. End of compressed data (EOI : End of Image)

EOI is a marker code indicating the end of entropy coded data, and is paired with SOI (see Figure 32). No specification is made regarding data arrays that come after EOI.



Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	1	FF	Marker Prefix
+01	1	D9	EOI

Figure 32 EOI Structure

4.7.2. Internal Structure of APP1 in Compressed Data

APP1 consists of an APP1 marker indicating that it is an application area, a length code indicating its size, and primary image attribute information patterned after the TIFF structure. The APP1 marker can not record more than 64 KBytes, a limitation that shall be kept in mind when recording thumbnail images. APP1 also records attribute information for JPEG compressed images. The features of this marker segment are described below.

4.7.2.1. Order of APP1 recording

APP1 shall be recorded immediately after the SOI marker indicating the start of the file (see Figure 7).

4.7.2.2. APP1 internal structure

APP1 consists of an APP1 marker, Exif ID code and the attribute information itself (see Figure 33).

Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	1	FF	Marker Prefix
+01	1	E1	APP1
+02	2		Length of field [Byte]
+04	4	45	'E'
		78	'x'
		69	'i'
		66	'f'
+08	1	00	NULL
+09	1	00	Padding
+0A	n		Attribute information
:			
:			

Figure 33 Basic Structure of APP1 Marker Segment

4.7.2.3. Exif ID code

The Exif ID code indicates that the internal of APP1 marker is Exif format. After a 4-byte code ‘Exif’, [00.H] is recorded in 2 Bytes. The reason for recording this code is to avoid duplication with other applications making use of JPEG application marker segments (APPn).

4.7.2.4. Attribute information

Attribute information can be recorded in 2 IFDs (0th IFD, 1st IFD) following the TIFF structure, including the File Header. The 0th IFD records compressed image attributes (the image itself). The 1st IFD may be used for thumbnail images.

4.7.2.5. TIFF header

The TIFF header in APP1 constitutes 8 Bytes of data, including the byte order and the Offset of IFD indicating the first IFD. The Offset is referenced to the address of the first byte of the Byte Order. For example, the Offset of IFD address in the TIFF Header is 4 (see Table 1).

4.7.2.6. Relation to JPEG marker segments

Attribute information is recorded in essentially the same format as that used to record uncompressed data attribute information. In order to avoid duplication, however, attribute information recorded in a JPEG marker segment shall not be recorded in APP1.

4.7.3. Internal Structure of APP2 for Flashpix in Compressed Data

APP2 for Flashpix consists of an APP2 marker segment indicating that it is an application area, a length code indicating its size, and Flashpix (see Annex F) extensions. If there is no need to record extensions, this marker segment may be omitted.

There are two kinds of APP2 marker segments for recording Flashpix extensions.

One is a Contents List Segment recording a storage and stream list making up the extended data. One file contains only one contents list segment.

The second is a Stream Data Segment storing the data for each of the streams listed in the Contents List Segment. If necessary, there may be two or more APP2 marker segments for storing stream data.

In addition there is an APP2 marker segment reserved for Flashpix use, which is specified in the Flashpix standard[18].

The contents of data that can be recorded as stream data is left for future specification. It may include one or more Audio data.

4.7.3.1. Order of APP2 recording

APP2 marker segments shall follow after the APP1 marker segment, in the order of Contents List Segment and Stream Data Segments. If there are two or more stream data segments, their order is as given in the contents list (see Figure 7).

4.7.3.2. APP2 internal structure

APP2 consists of an APP2 marker, ID code (FPXR), and Contents List or Stream Data (see Figure 34).

Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	1	FF	Marker Prefix
+01	1	E2	APP2
+02	2		Length of field [Byte]
+04	4	46	'F'
		50	'P'
		58	'X'
		52	'R'
+08	1	00	NULL
+09	1	00	Version
+0A : :	n		Contents List or Stream Data

Figure 34 Basic Structure of APP2 Marker Segment

4.7.3.3. FPXR ID code

The FPXR ID code indicates that the APP2 marker segment contains FPXR data. It is a 4-byte code 'FXPR' followed by [00.H] recorded in 1 Byte. The reason for recording this code is to avoid duplication with other applications making use of JPEG application marker segments (APPn). The subsequent byte gives the version number [00.H].

4.7.3.4. Contents list structure

The contents list segment lists the storages and streams to be created when the file is converted to a Flashpix image file. The first two bytes give the number of entryf.

The entry fields on the contents list are as follows.

- Entity size

  Indicates the size of the stream, or else FFFFFFFF.H (in the case of a storage). It is recorded in big endian format.

- Default value

  A fixed value not set explicitly in the stream data segment but used as the default for each byte.

- Storage/Stream name

  The name of the storage and stream added for transformation to Flashpix. It is given as the full path name from the Flashpix source image object root storage. "/" represents a directory separator and shall be the first character of the property value. This name is a 16-bit character string from the Unicode code page, with NULL termination. It is recorded in little endian format.

- Entity class ID

The storage ClassID, given only in the case of a storage entry. It is written as 16-byte in little endian format.

The data structure of the Contents List Segment is given in Figure 35.

Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	1	FF	Marker Prefix
+01	1	E2	APP2
+02	2		Length of field [Byte]
+04	4		“FPXR”
+08	1	00	NULL
+09	1	00	Version
+0A	1	01	Contents List
+0B	2		Entry Count
+0D	4		Entity size 0
+11	1		Default value 0
+12	m0		Storage / Stream name 0
+12 +m0	(n0)		(Entity Class ID 0)
+12 +m0 +n0	4		Entity size 1
:	1		Default value 1
:	m1		Storage / Stream name 1
:	(n1)		(Entity Class ID 1)
:	:	:	:
:	:	:	:
:	4		Entity size k
:	1		Default value k
:	mk		Storage / Stream name k
:	(nk)		(Entity Class ID k)

Figure 35 Contents List Segment Structure

4.7.3.5. Stream Data Segment structure

A stream data segment records part or all of the stream listed in the contents list segment. Because of the 64-KByte size limit of a JPEG marker segment, a stream longer than this shall be recorded in two or more stream data segments. Instead of writing stream data directly in multiple stream data segments, the segments may be filled based on a fixed default. A stream data segment can contain the following data.

・Index into Contents Lists

The order of entry recorded in a contents list segment starting from 0.

- Offset into the full Flashpix stream

  The offset to the first byte of stream data in the Flashpix stream.

- Stream Data

  The actual data stream recorded as extended data in the transformation to Flashpix. The length of this data is indicated by the length code in the stream data segment.

The data structure of a Stream Data Segment is given in Figure 36.

Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	1	FF	Marker Prefix
+01	1	E2	APP2
+02	2		Length of field [Byte]
+04	4		“FPXR”
+08	1	00	NULL
+09	1	00	Version
+0A	1	02	Stream Data
+0B	2	N	Index to Contents List
+0D	4		Offset to Flashpix stream
+11 :	m		Stream Data

Figure 36 Stream Data Segment Structure

4.7.3.6. Reserved Segment (Reserved for future use by the Flashpix format)

This marker segment is reserved for future use. An example is given in Figure 37.

Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	1	FF	Marker Prefix
+01	1	E2	APP2
+02	2		Length of field [Byte]
+04	4		“FPXR”
+08	1	00	NULL
+09	1	00	Version
+0A	1	03	Reserved for Flashpix
+0B :	: :	: :	

Figure 37 Structure of Reserved Segment for Flashpix

4.7.4. Internal Structure of APP2 for Original Preservation Image in Compressed Data

APP2 for an original preservation image consists of an APP2 marker, an MPF[3] ID code, and MP format attribute information (see the MPF standard[3]).

For specific specifications see Annex K.

4.7.5. Internal Structure of APP11 in Compressed Data

4.7.5.1. APP11

APP11 is a marker segment that stores metadata that uses a box data structure defined in JPEG Systems Part 5: JUMBF[10].

Annotation data of JPEG compressed images and the like is written in this marker in XML format or JSON (JSON-LD) format using the box data structure defined in the JUMBF standard[10] above. When recording, deleting, modifying, etc., data that uses a box structure, such as annotation data, the action shall be carried out in compliance with these standards.

For how to store a box structure see JPEG2000 Standard Part 1[8] and JPEG-XT Standard Part 3[9].

The following describes the details of the APP11 internal structure.

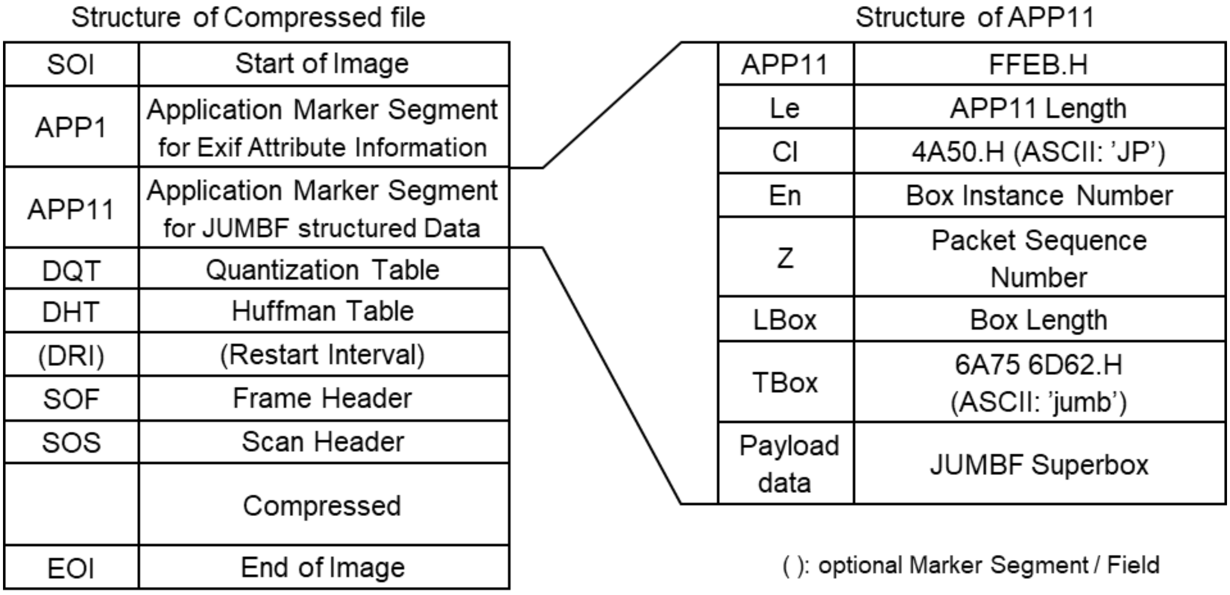
4.7.5.2. Order of APP11 Recording

APP11 shall be recorded after the APP1 and APP2 markers and before the DQT, DHT, DRI, SOF, and SOS markers.

4.7.5.3. APP11 Internal Structure

APP11 consists of an APP11 marker indicating that it is an application area, a length of field indicating its size, an ID code (JP), a box instance number, a packet sequence number indicating the sequence number of the packet when the marker exceeds 64 Kbytes and is divided into multiple segments, and a JUMBF Superbox that contains the JUMBF Box(es) for recording annotation data, etc.

Figure 38 shows the structure of APP11 including the JPEG box structure.



Structure of Compressed file

SOI	Start of Image
APP1	Application Marker Segment for Exif Attribute Information
APP11	Application Marker Segment for JUMBF structured Data
DQT	Quantization Table
DHT	Huffman Table
(DRI)	(Restart Interval)
SOF	Frame Header
SOS	Scan Header
	Compressed
EOI	End of Image

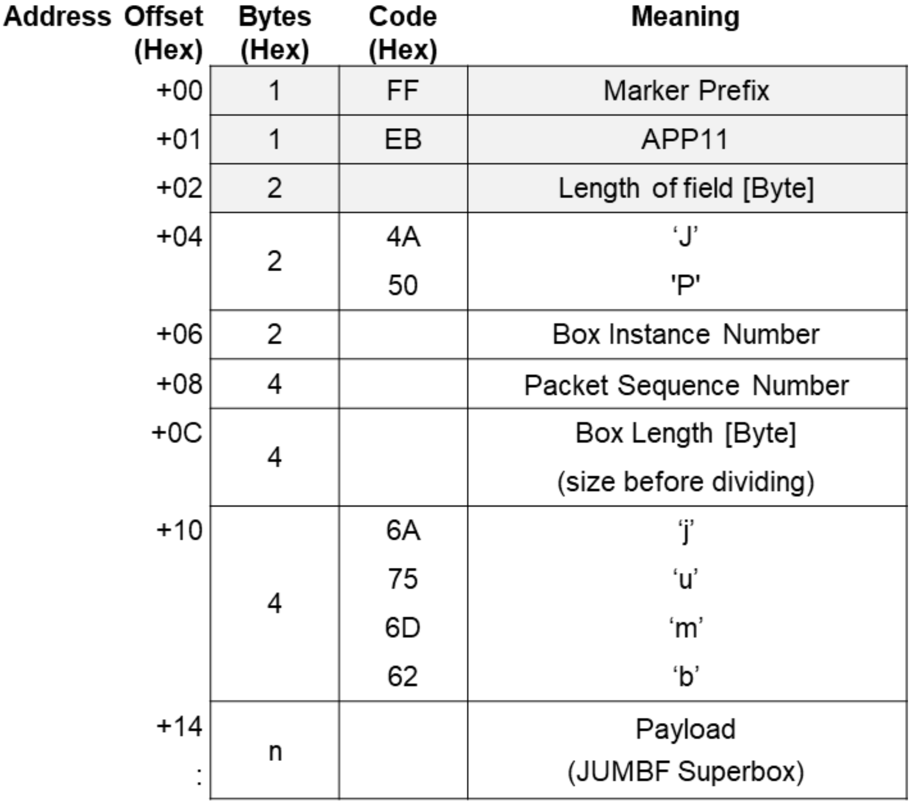
Structure of APP11

APP11	FFEB.H
Le	APP11 Length
CI	4A50.H (ASCII: ’JP’)
En	Box Instance Number
Z	Packet Sequence Number
LBox	Box Length
TBox	6A75 6D62.H (ASCII: ’jumb’)
Payload data	JUMBF Superbox

( ): optional Marker Segment / Field

Figure 38 APP11 Internal Structure

The data stored in an APP11 marker segmment is as follows.



Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	1	FF	Marker Prefix
+01	1	EB	APP11
+02	2		Length of field [Byte]
+04	2	4A 50	‘J’ 'P'
+06	2		Box Instance Number
+08	4		Packet Sequence Number
+0C	4		Box Length [Byte] (size before dividing)
+10	4	6A 75 6D 62	‘j’ ‘u’ ‘m’ ‘b’
+14 :	n		Payload (JUMBF Superbox)

Figure 39 Basic Structure of APP11 Marker

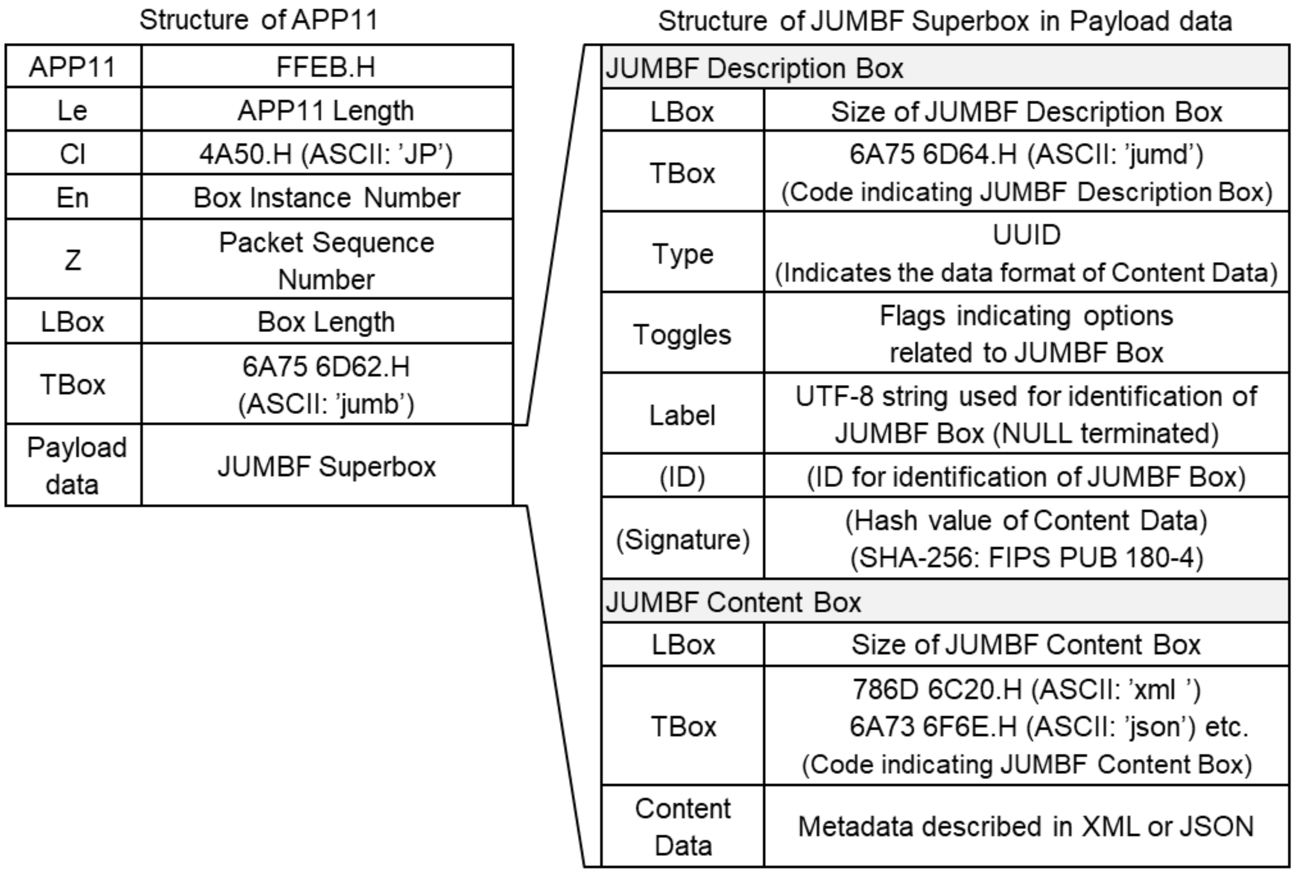
The four bytes of 'jumb' from the +10.H byte indicate that the subsequent payload data is a JUMBF Superbox.

4.7.5.4. JP ID Code

The JP ID code (CL) is an ID code indicating that APP11 consists of box structure data as defined in the JPEG-XT standard[9], etc., and the code 'JP' is written in 2 Bytes. The reason for recording this code is to avoid duplication with other applications making use of JPEG application marker segments (APPn).

4.7.5.5. Structure of JUMBF BOX

Figure 40 shows the structure of the JUMBF Box[10]. The JUMBF Superbox stored in the payload data of APP11 shown in section 4.7.5.3 consists of a JUMBF Description Box and a JUMBF Content Box.



Structure of APP11

APP11	FFEB.H
Le	APP11 Length
Cl	4A50.H (ASCII: 'JP')
En	Box Instance Number
Z	Packet Sequence Number
LBox	Box Length
TBox	6A75 6D62.H (ASCII: 'jumb')
Payload data	JUMBF Superbox

Structure of JUMBF Superbox in Payload data

JUMBF Description Box	
LBox	Size of JUMBF Description Box
TBox	6A75 6D64.H (ASCII: 'jumd') (Code indicating JUMBF Description Box)
Type	UUID (Indicates the data format of Content Data)
Toggles	Flags indicating options related to JUMBF Box
Label	UTF-8 string used for identification of JUMBF Box (NULL terminated)
(ID)	(ID for identification of JUMBF Box)
(Signature)	(Hash value of Content Data) (SHA-256: FIPS PUB 180-4)
JUMBF Content Box	
LBox	Size of JUMBF Content Box
TBox	786D 6C20.H (ASCII: 'xml ') 6A73 6F6E.H (ASCII: 'json') etc. (Code indicating JUMBF Content Box)
Content Data	Metadata described in XML or JSON

Figure 40 Structure of JUMBF BOX

The JUMBF Description Box stores the following data

Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	4		LBox [Byte] (Size of JUMBF Description Box)
+04	4	6A	‘j’
		75	‘u’
		6D	‘m’
		64	‘d’
+08	16	45	UUID[0] = ‘E’
		78	UUID[1] = ‘x’
		69	UUID[2] = ‘i’
		66	UUID[3] = ‘f’
		00	UUID[4]
		11	UUID[5]
		00	UUID[6]
		10	UUID[7]
		80	UUID[8]
		00	UUID[9]
		00	UUID[10]
		AA	UUID[11]
		00	UUID[12]
		38	UUID[13]
		9B	UUID[14]
		71	UUID[15]
+18	1	03	Toggles
+19 : :	n		Label (UTF-8 strings of any length)

Figure 41 Structure of JUMBF Description Box

The 4 bytes of 'jumd' from the +04.H byte indicate that this box is a JUMBF Description Box.

The 16 bytes from the +08.H byte are UUIDs indicating the type of JUMBF Content Box, and are set to the value below in this standard.

Exif JUMBF Metadata Box: 0x45786966(ASCII: ‘Exif’)-0011-0010-8000-00AA00389B71

The +18.H byte is a flag group specifying a JUMBF Box related option and, in this standard, 3.H (label exists and Content data can be requested from outside) is specified to define the subsequent label. Note that, when ID or Signature is specified, a flag indicating use of these options can also be set.

The 2 bytes from the +19.H byte are a UTF-8 string (NULL terminated) for identifying the Content data. For the Label strings corresponding to the respective Content data, see Chapter 6.

The JUMBF Content Box stores the following data.

Address Offset (Hex)	Bytes (Hex)	Code (Hex)		Meaning	
+00	4			LBox [Byte] (Size of JUMBF Content Box)	
+04	4	78	6A	‘x’	‘j’
		6D	73	‘m’	‘s’
		6C	6F	‘l’	‘o’
		20	6E	‘ ’	‘n’
+08 : :	n			Content data	

Figure 42 Structure of JUMBF Content Box

The 4 bytes from the +04.H byte define the syntax of the Content data, and are the following values for descriptions in XML format and JSON (JSON-LD) format, respectively.

XML format:	786D6C20.H (ASCII: ‘xml')
JSON (JSON-LD) format:	6A736F6E.H (ASCII: ‘json'）

The area from the +08.H byte stores the various XML format document or JSON (JSON-LD) format metadata. The specifications regarding the metadata that can be stored are described in Chapter 6.

4.8. Data Description

4.8.1. Stipulations on Compressed Image Size

The JPEG format is adopted for compressed images. Since JPEG compresses images in blocks of 8 x 8 pixels, preferably the pixel number set as the width and height of the image should be exact multiples of the MCU (multiples of 16 for width, and multiples of 8 for height if Y:Cb:Cr = 4:2:2, or 16 if Y:Cb:Cr = 4:2:0). It is not required, however, that all image data be fit within this range. If a restart marker is inserted every 4 MCU for the sake of transformation to Flashpix, the width of the image shall be an exact multiple of 4 MCU (64 pixels). There is no such restriction on height.

Specifications on inserting data to adjust the recorded image size relative to the valid image size, or padding, are given below.

4.8.1.1. Image size recording procedure in the Exif/DCF writer

An Exif/DCF writer shall record a compressed image with the image width information and height information set in accord with the stipulations below, and padded as necessary. When the image is padded in the direction of width, the padding data shall be appended at the right edge. Padding in the direction of height shall be appended at the bottom edge.

The data used for padding is not specified.

[Stipulations on image width]

Image width information consists of the valid image width tag (PixelXDimension), SOF marker information, and JPEG compressed data. Of these three, the recording of a valid image width tag is mandatory.

Image width is padded to the right in the following cases. The value used for padding is not specified.

- When the image width is not an exact multiple of 16 and the JPEG block has unused capacity to be filled.
- When the image width is not a multiple of 64 and the insufficiency shall be made up in order to insert restart markers.

The method of describing the various image width data with and without padding is given in Figure 43.

It shall be noted carefully that the value of SOF is used in some cases to describe the valid image width, and in others to describe the image width after padding.

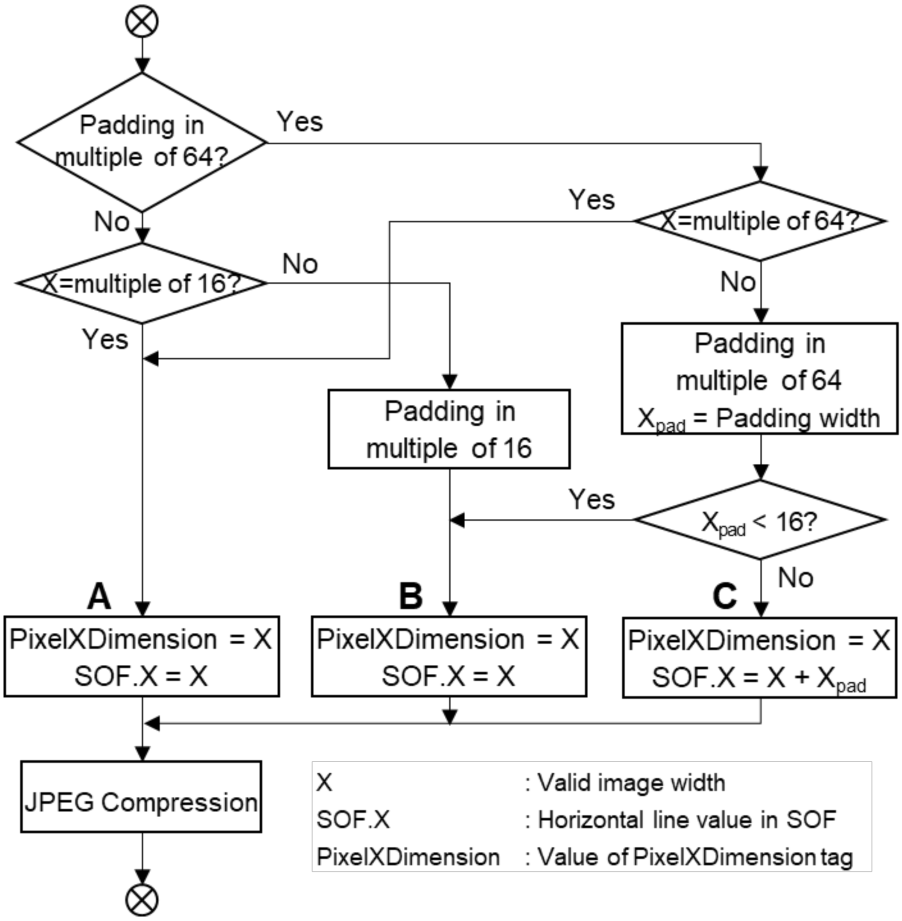


Figure 43 Image Data Width Description

Table 23 gives examples of information recorded in the direction of image width and padding data width, for each of cases A, B, and C of Figure 43.

Table 23 Typical Width Direction Information and Padding Data

	Valid Image Width	PixelXDimension	SOF Information	Compressed Data	Padding Width
A	640	640	640	640	0
B	634	634	634	640	6 (< 1MCU)
C	620	620	640	640	20 (> 1MCU)

[Stipulations on image height]

Image height information consists of the valid image height tag (PixelYDimension), SOF marker information, and JPEG compressed data. Of these three, the recording of a valid image height tag is mandatory.

The image height is padded in the following case. The padding value is not specified.

When the image height is not an exact multiple of 16 and the JPEG block has unused capacity to be filled.

Insertion of a restart marker does not require padding. The method of recording the various image height data with and without padding is given in Figure 44. The SOF marker always has the same value as the effective image height tag.

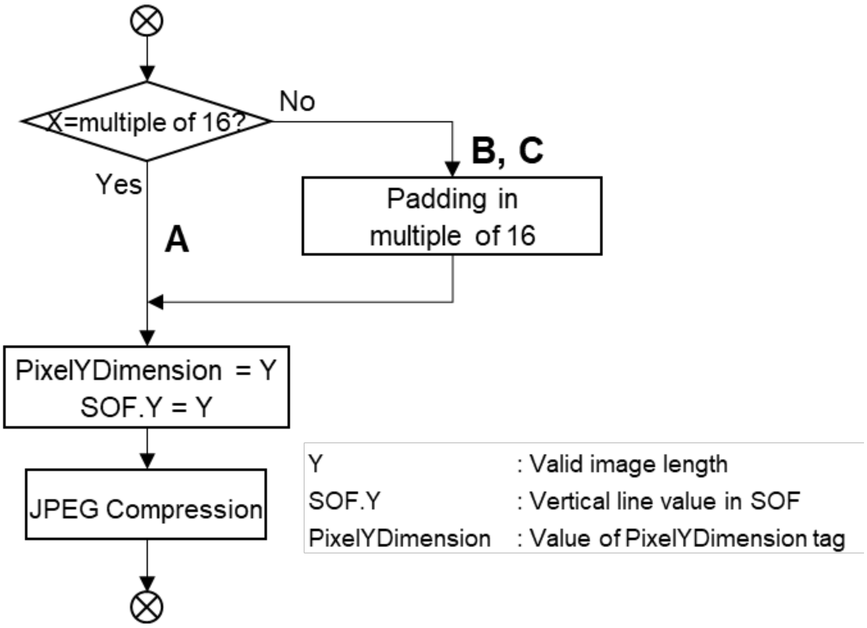

X=multiple of 16?
No
B, C
Yes
A
Padding in multiple of 16
PixelYDimension = Y
SOF.Y = Y
JPEG Compression
Y : Valid image length
SOF.Y : Vertical line value in SOF
PixelYDimension : Value of PixelYDimension tag

Figure 44 Image Data Height Description

Table 24 gives examples of information recorded in the direction of image height and padding data height, for each of cases A, B, and C of Figure 44.

Table 24 Typical Height Direction Information and Padding Data (when Y:Cb:Cr = 4:2:2)

	Valid Image Height	PixelYDimension	SOF Information	Compressed Data	Padding Height
A	480	480	480	480	0
B	474	474	474	480	6 (< 1MCU)
C	460	460	460	464	4 (< 1MCU)

4.8.1.2. Image size reproduction procedure in the Exif/DCF reader

It is recommended that the Exif/DCF reader (and in particular, specialized software) follow the procedureshown in Figure 45 for reproducing images. First it expands the image based on the SOF information.

Next it trims the image on the right and lower edges in accord with information in the valid image width tag and height tag, and reproduces the valid image data. If the SOF information and the valid imagewidth and height tag information are the same, trimming is unnecessary.

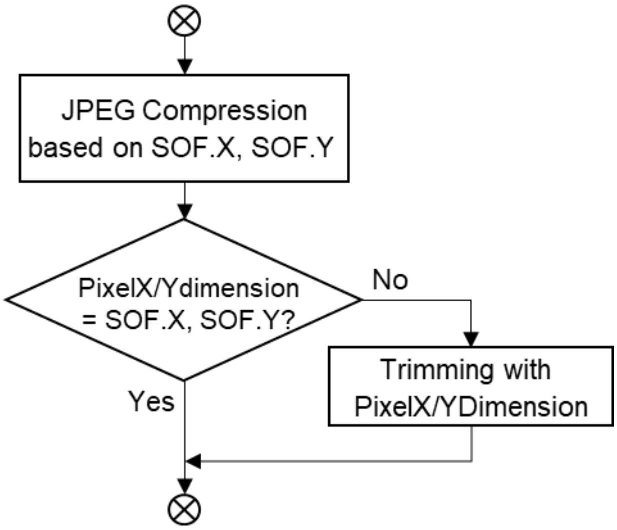

JPEG Compression based on SOF.X, SOF.Y
PixelX/Ydimension = SOF.X, SOF.Y?
No
Trimming with PixelX/YDimension
Yes

Figure 45 Procedure for Image Data Reproduction

Some off-the-shelf software lacks a function for handling valid image width and height tags. If the valid image width differs from the number of horizontal pixels recorded in the SOF, padding data may be displayed. The padding data values should be chosen with this possibility in mind.

4.8.2. Stipulations on Thumbnails

4.8.2.1. Exif/DCF writer

The recording of thumbnail images is an optional specification of the Exif/DCF reader. It is therefore allowable to have Exif files with and without thumbnails. For details see section 4.5.8

4.8.2.2. Exif/DCF reader

This format shall be designed so that the primary image will be reproduced intact whether or not thumbnail images are recorded in the file. It is assumed that even when functions are provided for viewing images on the camera or player, for viewing the process of image transfer from camera to PC, or for using thumbnails as an index display in the camera software or other image software, there will still be cases where the file is viewed without thumbnails. The creation and displaying of thumbnails should therefore be performed or not at the discretion of the user.

4.8.3. File Name Stipulations

4.8.3.1. Exif/DCF writer

The file name and characters used for file names are not specified, other than to stipulate the use of ASCII alphanumerics. (File names in Japanese or other character sets are not to be used.) File names shall be 8 characters or fewer, not including the extension. (Long file names are not to be used.) The file name extensions are ".JPG" for compressed data files and ".TIF" for uncompressed data files.

4.8.4. Byte Order Stipulations

4.8.4.1. Exif/DCF reader

It is recommended that the Exif/DCF reader be able to reproduce Exif files recorded in both little endian and big endian formats.

5. Exif Audio File Specification

5.1. Outline of the Exif Audio File Specification

This chapter gives details of the audio file specification, covering the following items:

- Format version definition,
- Specifications relating to audio data,
- Basic structure of audio data,
- Chunks,
- File naming conventions.

5.2. Format Version

The version of the format specified here is recorded as 4 bytes (see section 5.6.3). The address bytes are recorded as A1, A2, B1, B2, starting with the lowest number. A1 and A2 store the upper part of the standard version, with the lower part stored in B1 and B2. When changes are made to the version number of this standard, the following rules apply:

- When the changes are such that data readers can properly recognize conventional information and skip the data that was recorded using newly added functions, the lower part of the version (B1, B2) is changed,
- When there is a possibility that a data reader implementing the old standard may operate incorrectly due to the new specifications, the upper part of the version (A1, A2) is changed.

Players should be able to play back files of versions earlier than the supported standard.

5.3. Definition of Terms

Terms and notation are used as follows in this section:

- Text enclosed in " " is a character string, and " "Z means a character string ending in NULL[00.H]

5.4. Specifications Relating to Audio Data

5.4.1. Sampling Frequency

The sampling frequency shall be any of 8.000 KHz, 11.025 KHz, 22.050 KHz, 32.000 KHz, 44.100 KHz, 48.000 KHz, 96.000 KHz or 192.000KHz. As an exception, only 8.000KHz shall be used for μ-LAW PCM in accordance with ITU-T G.711; 8.000 KHz, 11.025 KHz, 22.050 KHz, or 44.100 KHz shall be used for IMA-ADPCM as recommended by the IMA (Interactive Multimedia Association)[25].

See section 5.5.3 and 5.5.4 for details.

5.4.2. Bit Size

The bit size shall be 8 bits,16 bits or 24 bits. The exceptions are only 8 bits shall be used for μ-LAW PCM in accord with ITU-T G.711; and only 4 bits shall be used for IMA-ADPCM in accord with the IMA (Interactive Multimedia Association) specification[25].

See section 5.5.3 and 5.5.4 for details.

5.4.3. Channels

The number of channels shall be either monaural or stereo (2 ch).

5.4.4. Compression Schemes

The following three compressions schemes are specified here:

- Uncompressed audio data: PCM ,
- Uncompressed audio data: μ-Law PCM (conforming to ITU-T G.711),
- Compressed data: IMA-ADPCM.

5.5. Basic Structure of Audio Data

Exif audio files are based on the RIFF WAVE Form Audio File format[19] adopted as a Windows™ standard audio file format, with the addition of various DSC attribute information as needed. Exif audio files are data-compatible with WAVE Form Audio files and can be played on accessories supplied with Windows™.

Of the general attribute information required by DSC applications, the common attributes are recorded on an INFO list, and the Exif-specific attributes are recorded in Exif chunks. The Exif chunks are provided to enable the addition of information as necessary, taking advantage of chunk extensibility. The method of recording data in the Exif-specific chunks is patterned after that for the INFO list.

5.5.1. Basic Structure of WAVE Form Audio Files

The WAVE Form Audio File format is based on the RIFF (Resource Interchange File Format) tagged file structure.

A RIFF file consists of basic data blocks called chunks.

5.5.1.1. Chunk

Using C language syntax, a chunk may be defined as a structure, like that in Equation 1. The chunk structure may also be expressed in graphical form as in Figure 46.

```
typedef struct {
   unsigned long   ckID;              // 4-character code
   unsigned long   ckSize;            // Size of member <ckData>
   unsigned char   ckData[ckSize];    // The data in the chunk
} CK;                                    - - -[Equation 1]
```

Address Offset (Hex)	Bytes (Hex)	Code
+00	4	ckID
+04	4	ckSize
+08	ckSize	ckData

Figure 46 Chunk Structure

ckID (chunk ID, a 4-character code) consists of from one to four ASCII alphanumerics, left-justified and filled with blank characters if less than four characters in length. Blanks can not be inserted between characters. This four-character code identifies the contents of the chunk data, described later. Software processing the chunk may be skiped if its chunk ID is unknown..

ckSize (chunk Size) is a 32-bit unsigned integer giving the size (bytes) of the ckData[ckSize] (chunk Data). This size does not include padding bytes following the ckID, ckSize itself and ckData. The byte order is little endian (LSB first, MSB last). In the case of RIFF files, values of more than one byte are all written in little endian order. If two or more chunks follow in sequence, the value of chSize shall be read properly in order to know the start address (ckID) of the next chunk.

ckData[ckSize] (chunk Data) is the actual data included in that chunk, and may be recorded as binary data of either fixed length or variable length. The start of ckData is aligned with the RIFF file start position in word (16-bit) units. If the data size is an odd number of bytes, a padding byte with the value '0' is appended after the ckData. This padding byte is not included in the ckSize (chunk Size).

ckData[ckSize] (chunk Data) can itself have a particular structure rather than being a simple byte array. That is, ckData itself may include a chunk (sub-chunk). In other words, chunks may be arranged hierarchically. Only certain chunks are allowed to contain sub-chunks. These are the RIFF chunk and LIST chunk described later below. Generally two or more sub-chunks may be contained in these chunks.

All other chunks store only one binary data element in the ckData.

5.5.1.2. RIFF Form

A "RIFF form" is a chunk with "RIFF" as its chunk ID (ckID); it is also used to mean a file format with the RIFF structure (RIFF file).

A "RIFF chunk" ckData (chunk data) consists of a 4-character code at the beginning called the formType (form type), followed by a sub-chunk.

A RIFF chunk is at the top of the chunk hierarchy. A RIFF form shall have this chunk, but may have only one. All other chunks are sub-chunks of the RIFF chunk.

A form type is generally a code identifying the data contents, among other things. It is also possible to tell from this code what kind of sub-chunk a chunk contains. A form type shall be registered. A registered form type is written in all upper-case letters.

Along with a form type, a chunk ID (ckID) shall also be registered. A chunk ID in all upper-case letters indicates a general-purpose chunk that may be used with various form types. A chunk ID used with a specific form type is written in all lower-case letters.

An illustration of the RIFF chunk is given in Figure 47.

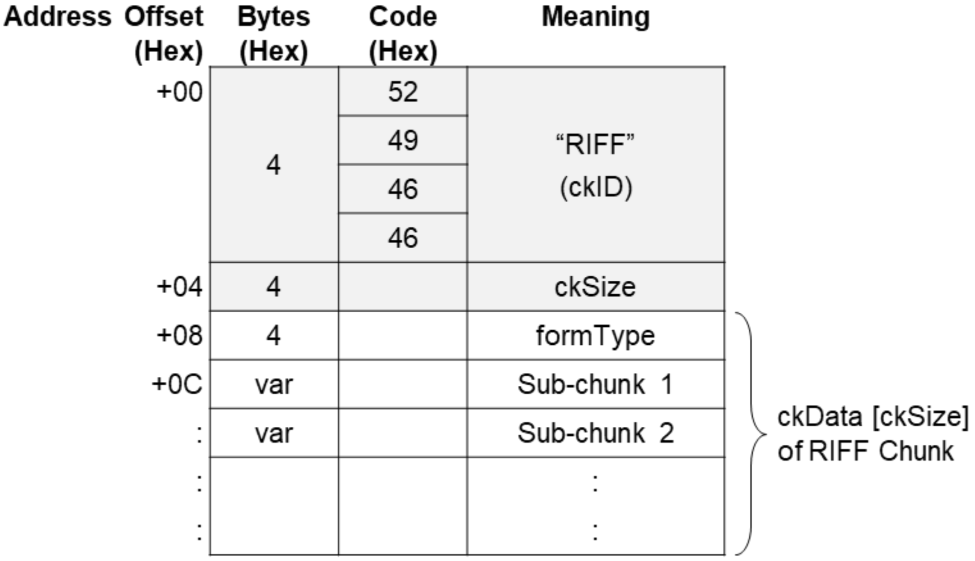


Figure 47 RIFF Chunk Structure

Note Representative form types are given in Table 25. These are written in all upper-case letters because they are registered form types.

Table 25 Representative Form Types

Form Type	Name
PAL	Palette file form
RDIB	RIFF DIB (Device Independent Bitmap) form
RMID	RIFF MIDI form
RMMP	RIFF multimedia movie form
WAVE	WAVE Form Audio File format

5.5.1.3. WAVE Form Audio File Format

The WAVE Form is one kind of RIFF form. It is a file for handling digitized sound data. The form type is WAVE, in upper-case letters.

The file extension for a WAVE Form Audio File is ".WAV".

The data structure of the WAVE Form Audio File format is shown in Figure 48.

As is evident from Figure 48, the chunk data (ckData [ckSize]) of a RIFF chunk generally consists of the formType ("WAVE"), fmt-ck (format chunk), fact-ck (fact chunk), and data-ck (data chunk). fmt-ck and data-ck are mandatory chunks, but fact-ck may be mandatory or not, depending on the format type (audio coding format) of the WAVE Form.

In addition to these, optional sub-chunks may be recorded and may store various attribute information.

These optional sub-chunks are not shown in Figure 48.

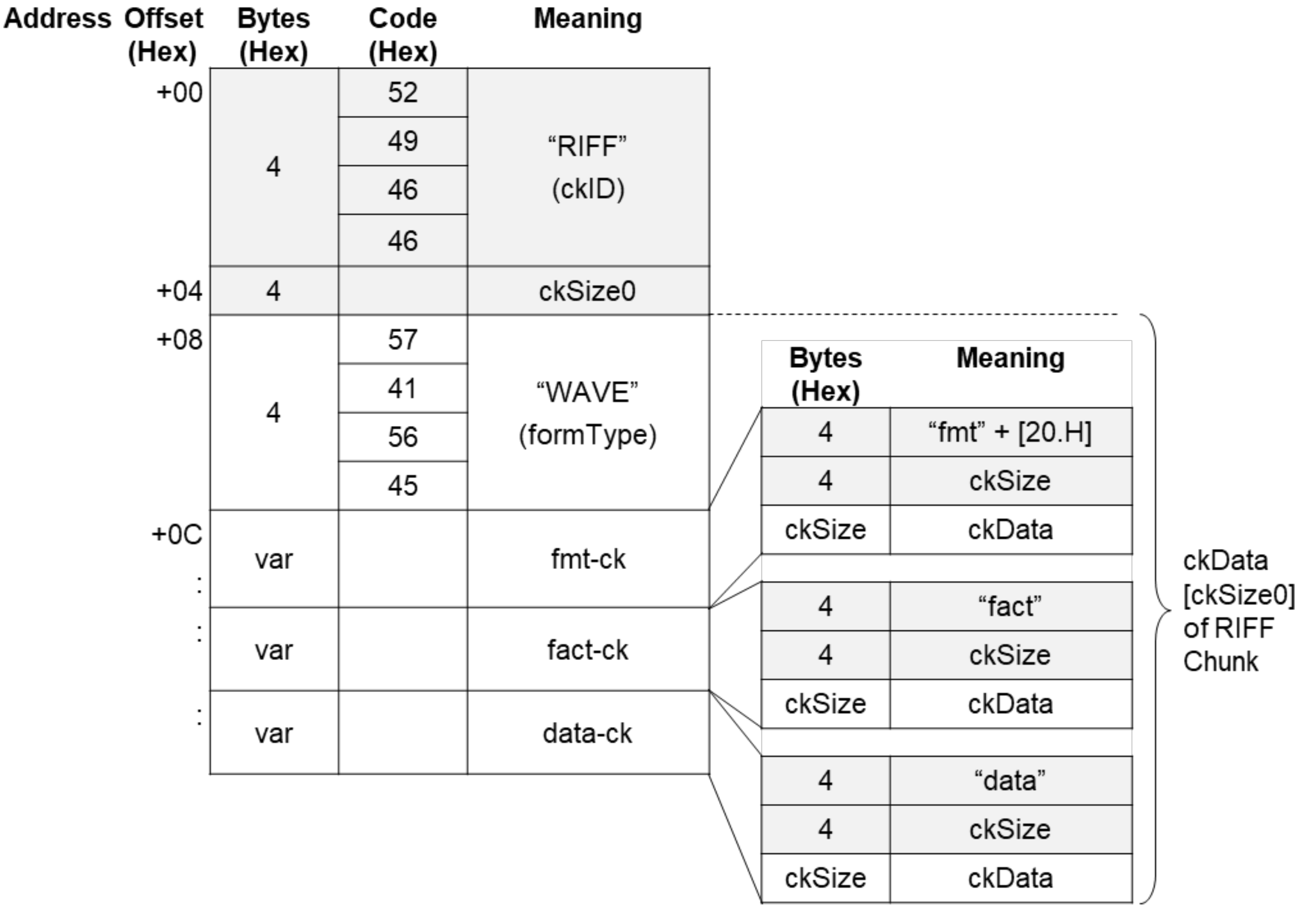


Figure 48 Data Structure of the WAVE Form Audio File Format

<fmt-ck>

fmt-ck (format chunk) contains format information designating the format of audio data included in the data-ck (data chunk) described later below. The ckID (chunk ID) of fmt-ck is "fmt."

"fmt " is 3 characters long, so a blank character[20.H] goes at the end.

fmt-ck is mandatory and shall always be recorded before data-ck.

Since fmt-ck has the chunk structure, ckSize and ckData[ckSize] are included as its members; but the contents of the ckData depend on the format type (audio coding format). This ckData consists of the structure given in Equation 2, and the byte array given in Equation 3.

```
struct{
   unsigned int   wFormatTag;         // Format type
   unsigned int   nChannels;          // Number of channels
   unsigned long  nSamplesPerSec;     // Sampling rate
   unsigned long  nAvgBytesPerSec;    // Average bytes per second
   unsigned int   nBlockAlign;        // Block alignment
   unsigned int   wBitsPerSample;     // Bits per sample
   unsigned int   cbSize;             // Additional bytes
} WAVEFORMATEX;                                 - - -[Equation 2]
unsigned char
   extByte[cbSize];   // Additional byte array  - - -[Equation 3]
```

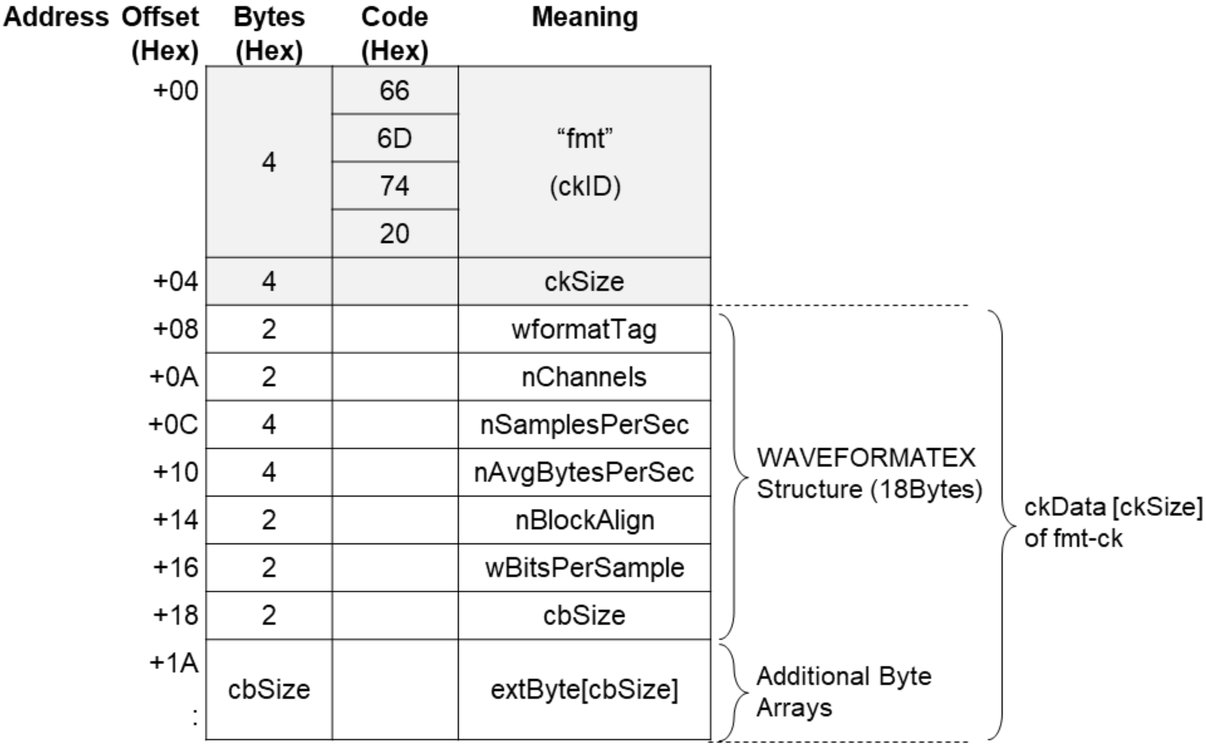
The meaning of each member of the format information is given in Table 26.

Table 26 Format Information Members

Member	Description
wFormatTag	An unsigned 16-bit integer indicating the format type (audio coding format) of the WAVE Form. Typical format types are given below. PCM (Pulse Code Modulation) format: 0001.H μ-Law format (ITU-T G.711): 0007.H IMA-ADPCM (DVI-ADPCM) format: 0011.H
nChannels	An unsigned 16-bit integer indicating the number of channels. Monaural is 1 and stereo is 2.
nSamplesPerSec	An unsigned 32-bit integer indicating the sampling rate (samples per second). Audio is played in each channel at this rate. In PCM format the common values of this member are 8.000KHz, 11.025KHz, 22.050KHz, 32.000KHz, 44.100KHz, 48.000KHz, 96.000KHz, and 192.000KHz.
nAvgBytesPerSec	An unsigned 32-bit integer indicating the average bytes per second, a value transferred to the data in data-ck. In PCM format, nAvgBytesPerSec is equivalent to the equation below. nSamplesPerSec * nBlockAlign
nBlockAlign	An unsigned 16-bit integer indicating the (byte unit) block alignment in data-ck. In PCM format, nBlockAlign is equivalent to the equation below. nChannels * wBitsPerSample/8

wBitsPerSample	An unsigned 16-bit integer indicating the bits per sample of each channel. In PCM format, this value is 8 ,16 or 24. In the case of compressed sound data, when this value can not be defined it becomes '0'.
cbSize	An unsigned 16-bit integer indicating the size (in bytes) of the additional format information extByte[cbSize] appended after the WAVEFORMATEX structure. This information is used to store attributes added in non-PCM formats. If additional information is not needed, it becomes '0'. In PCM format, this member is not needed (the cbSize field itself is not necessary).
extByte[cbSize]	A byte array representing the additional format information appended after the WAVEFORMATEX structure. The meaning of this information depends on the format type. If the value of cbSize is 0, this field does not exist. In PCM format, both the cbSize field and extByte[cbSize] field are unnecessary.

The fmt-ck structure can be illustrated as in Figure 49.



Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	4	66 6D 74 20	“fmt” (ckID)
+04	4		ckSize
+08	2		wformatTag
+0A	2		nChannels
+0C	4		nSamplesPerSec
+10	4		nAvgBytesPerSec
+14	2		nBlockAlign
+16	2		wBitsPerSample
+18	2		cbSize
+1A :	cbSize		extByte[cbSize]

Figure 49 fmt-ck Structure

<fact-ck>

fact-ck (fact chunk) is used to store file-dependent information relating to the WAVE file contents. The ckID (chunk ID) of fact-ck is "fact".

It is assumed that fact-ck will be extended in the future to store information needed by WAVE files at that time, but currently only one information member is defined.

The information that can be stored in fact-ck at the present time is defined in Equation 4.

```
unsigned long  dwSampleLength;  // Sample length- - - [Equation 4]
```

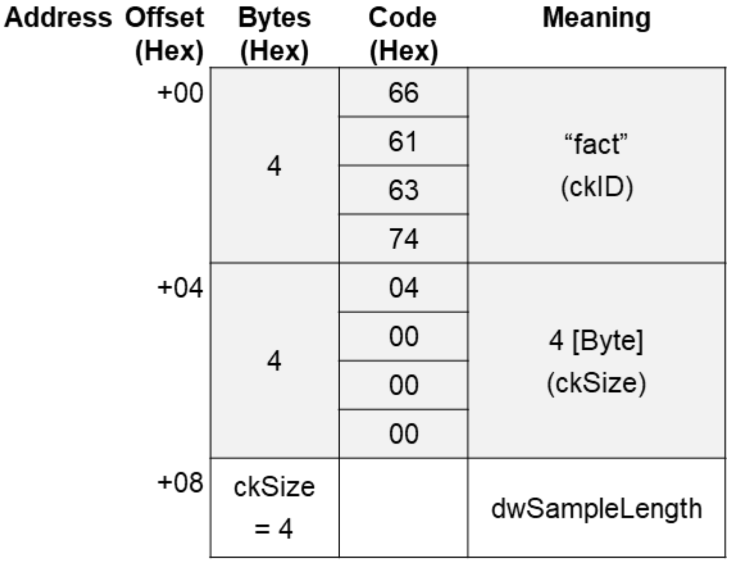
The meaning of each member of the format information is given in.Table 27.

Table 27 fact-ck Member

Member	Description
dwSampleLength	An unsigned 32-bit integer indicating the number of audio data samples (sample length). When this information is combined with nSamplePerSec in fmt-ck, the data length can be expressed in seconds (recording time).

Since the only information defined presently is dwSampleLength, the value of ckSize (chunk Size) for fact-ck is 00000004.H; but ckSize may change in the future as information is added (in which case it will be larger than 00000004.H). Programs shall be able to skip over fields they can not interpret and go on to process the next chunk. For this reason the capability of correctly reading the value of ckSize is a necessary requirement.

The structure of fact-ck is illustrated in Figure 50. The value of ckSize is fixed at 00000004.H (this value is used in Write processing).



Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	4	66	"fact" (ckID)
		61	
		63	
		74	
+04	4	04	4 [Byte] (ckSize)
		00	
		00	
		00	
+08	ckSize = 4		dwSampleLength

Figure 50 fact-ck Structure

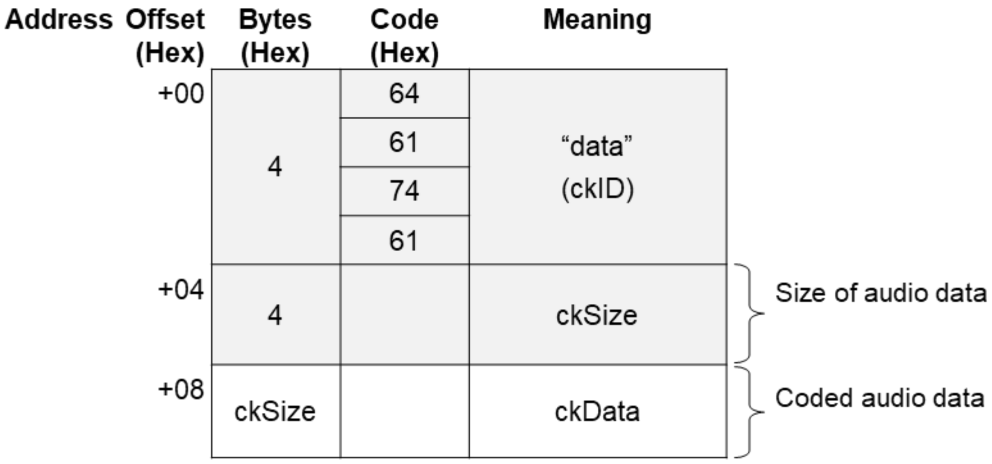
<data-ck>

data-ck (data chunk) is a chunk for storing audio data. Its ckID (chunk ID) is "data".

The ckData (chunk Data) of data-ck consists of the audio data only. In some cases the chunk is filled out with padding bytes.

The audio data is coded based on the format type. The information in fmt-ck is used when the audio data is played back.

The ckSize (chunk Size) of data-ck is the size of the coded audio data only. The structure of data-ck is illustrated in Figure 51.



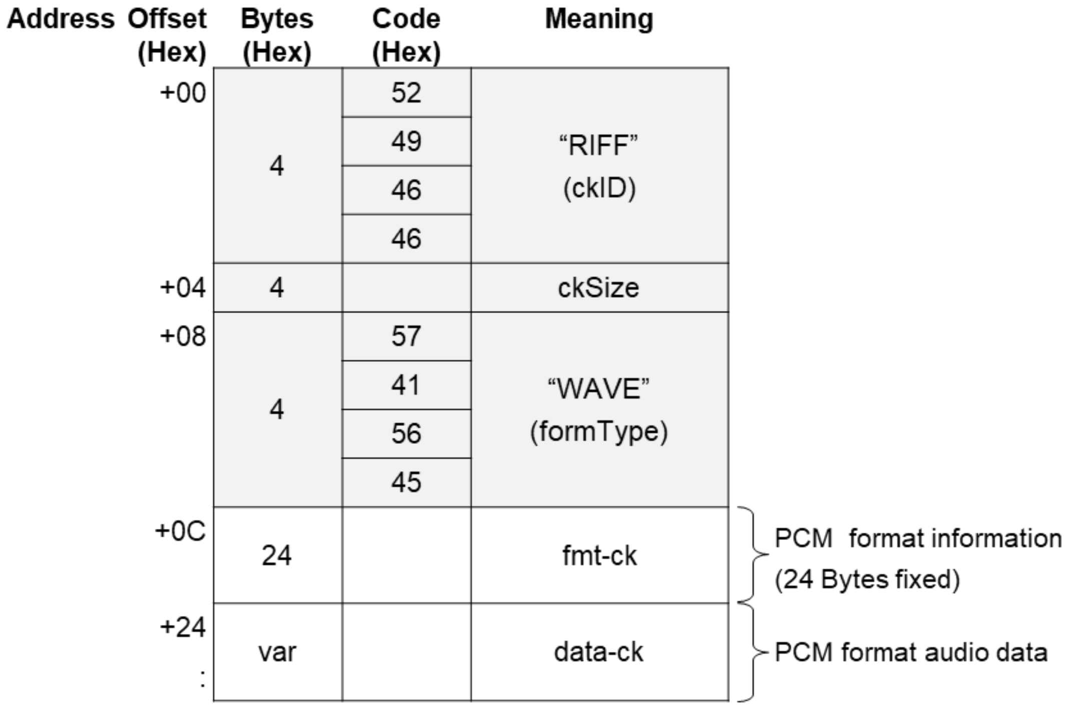
Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	4	64 61 74 61	"data" (ckID)
+04	4		ckSize
+08	ckSize		ckData

Figure 51 data-ck Structure

5.5.2. Basic Structure of PCM Audio Data

PCM audio data has linear quantization (A/D conversion) characteristics, and is not encoded for compression. It therefore does not need to be decompressed for playback, but can simply be played by reading it directly.

The basic structure of audio data when the format type is PCM (Pulse Code Modulation) format is shown in Figure 52.



Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	4	52	"RIFF" (ckID)
		49	
		46	
		46	
+04	4		ckSize
+08	4	57	"WAVE" (formType)
		41	
		56	
		45	
+0C	24		fmt-ck
+24 :	var		data-ck

Figure 52 Basic Structure of PCM Format

The specific values stored in fmt-ck in the case of PCM format are as shown in Table 28.

Table 28 PCM Format fmt-ck Information

PCM (Pulse Code Modulation) Format	
Members	**Code**
ckSize (fmt-ck)	00000010.H (16 Bytes, since cbSize is unnecessary)
wFormatTag	0001.H (PCM format)
nChannels	The values of each mode are as follows. 0001.H (monaural) or 0002.H (stereo)
nSamplesPerSec	The values of each mode are as follows. 00001F40.H (8.000KHz) 00002B11.H (11.025 KHz) 00005622.H (22.050KHz) 00007D00.H (32.000KHz) 0000AC44.H (44.100KHz) 0000BB80.H (48.000KHz) 00017700.H (96.000KHz) 0002EE00.H (192.000KHz)
nAvgBytesPerSec	The values of each mode are as follows.

	00001F40.H (8.000KHz, 8-bit monaural) 00003E80.H (8.000KHz, 8-bit stereo) 00003E80.H (8.000KHz, 16-bit monaural) 00007D00.H (8.000KHz, 16-bit stereo) 00005DC0.H (8.000KHz, 24-bit monaural) 0000BB80.H (8.000KHz, 24-bit stereo) 00002B11.H (11.025 KHz, 8-bit monaural) 00005622.H (11.025 KHz, 8-bit stereo) 00005622.H (11.025 KHz, 16-bit monaural) 0000AC44.H (11.025 KHz, 16-bit stereo) 00008133.H (11.025KHz, 24-bit monaural) 00010266.H (11.025KHz, 24-bit stereo) 00005622.H (22.050KHz, 8-bit monaural) 0000AC44.H (22.050KHz, 8-bit stereo) 0000AC44.H (22.050KHz, 16-bit monaural) 00015888.H (22.050KHz, 16-bit stereo) 00010266.H (22.050KHz, 24-bit monaural) 000204CC.H (22.050KHz, 24-bit stereo) 00007D00.H (32.000KHz, 8-bit monaural) 0000FA00.H (32.000KHz, 8-bit stereo) 0000FA00.H (32.000KHz, 16-bit monaural) 0001F400.H (32.000KHz, 16-bit stereo) 00017700.H (32.000KHz, 24-bit monaural) 0002EE00.H (32.000KHz, 24-bit stereo) 0000AC44.H (44.100KHz, 8-bit monaural) 00015888.H (44.100KHz, 8-bit stereo) 00015888.H (44.100KHz, 16-bit monaural) 0002B110.H (44.100KHz, 16-bit stereo) 000204CC.H (44.100KHz, 24-bit monaural) 00040998.H (44.100KHz, 24-bit stereo) 0000BB80.H (48.000KHz, 8-bit monaural) 00017700.H (48.000KHz, 8-bit stereo) 00017700.H (48.000KHz, 16-bit monaural) 0002EE00.H (48.000KHz, 16-bit stereo) 00023280.H (48.000KHz, 24-bit monaural) 00046500.H (48.000KHz, 24-bit stereo) 00017700.H (96.000KHz, 8-bit monaural)

	0002EE00.H (96.000KHz, 8-bit stereo) 0002EE00.H (96.000KHz, 16-bit monaural) 0005DC00.H (96.000KHz, 16-bit stereo) 00046500.H (96.000KHz, 24-bit monaural) 0008CA00.H (96.000KHz, 24-bit stereo) 0002EE00.H (192.000KHz, 8-bit monaural) 0005DC00.H (192.000KHz, 8-bit stereo) 0005DC00.H (192.000KHz, 16-bit monaural) 000BB800.H (192.000KHz, 16-bit stereo) 0008CA00.H (192.000KHz, 24-bit monaural) 00119400.H (192.000KHz, 24-bit stereo) Definition: `nSamplesPerSec * nBlockAlign`
nBlockAlign	The values of each mode are as follows. 0001.H (8-bit monaural) 0002.H (8-bit stereo) 0002.H (16-bit monaural) 0004.H (16-bit stereo) 0003.H (24-bit monaural) 0006.H (24-bit stereo) Definition: `nChannels * wBitsPerSample / 8`
wBitsPerSample	The values of each mode are as follows. 0008.H (8bit) or 0010.H (16bit) or 0018.H (24bit)
cbSize	Not used
extByte[cbSize]	Not used

In the case of PCM format audio data, the data format of each sample is 8-bit or 16-bit integer. These sample data formats and their values are given in Table 29.

Table 29 Sample Data Formats and Values

Sample Size	Data Format	Minimum	Intermediate	Maximum
8-bit PCM	Unsigned Integer	0 (00.H)	128 (80.H)	255 (FF.H)
16-bit PCM	Signed Integer	-32768 (8000.H)	0 (0000.H)	32767 (7FFF.H)
24-bit PCM	Signed Integer	-8388608 (800000.H)	0 (0000.H)	8388607 (7FFFFF.H)

The PCM format audio data contained in data-ck is packed as shown in Figure 53. Here the left-hand byte stores the lower address and the right-hand byte holds the upper address.

Sample 0	Sample 1	Sample 2	Sample 3
Channel 0	Channel 0	Channel 0	Channel 0
Byte 0	Byte 1	Byte 2	Byte 3

(a) 8-bit monaural PCM

Sample 0		Sample 1	
Channel 0 (left)	Channel 1 (right)	Channel 0 (left)	Channel 1 (right)
Byte 0	Byte 1	Byte 2	Byte 3

(b) 8-bit stereo PCM

Sample 0		Sample 1	
Channel 0 Lower Byte	Channel 0 Upper Byte	Channel 0 Lower Byte	Channel 0 Upper Byte
Byte 0	Byte 1	Byte 2	Byte 3

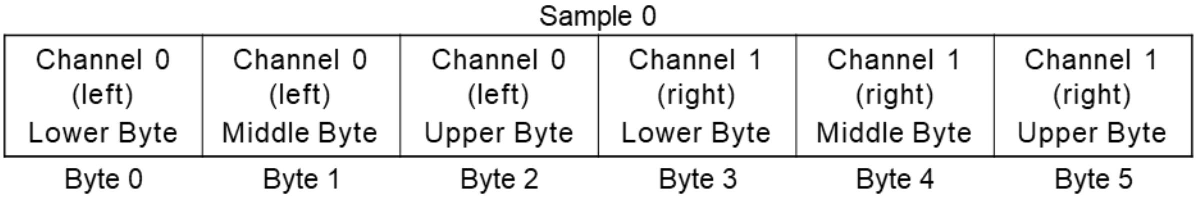
(c) 16-bit monaural PCM

Sample 0			
Channel 0 (left) Lower Byte	Channel 0 (left) Upper Byte	Channel 1 (right) Lower Byte	Channel 1 (right) Upper Byte
Byte 0	Byte 1	Byte 2	Byte 3

(d) 16-bit stereo PCM

Sample 0			Sample 1		
Channel 0 Lower Byte	Channel 0 Middle Byte	Channel 0 Upper Byte	Channel 0 Lower Byte	Channel 0 Middle Byte	Channel 0 Upper Byte
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5

e) 24-bit monaural PCM


Sample 0
Channel 0 (left) Lower Byte
Channel 0 (left) Middle Byte
Channel 0 (left) Upper Byte
Channel 1 (right) Lower Byte
Channel 1 (right) Middle Byte
Channel 1 (right) Upper Byte
Byte 0
Byte 1
Byte 2
Byte 3
Byte 4
Byte 5

(f) 24-bit stereo PCM

Figure 53 Packing of PCM Audio Data

5.5.3. Basic Structure of μ-Law Audio Data

Each of the audio data samples of μ-Law audio data has nonlinear (logarithmic) quantization characteristics. For this reason 16 bits of data can be represented in an 8-bit size. In playback, either the data is first converted to linear 16-bit data and then put through a linear D/A converter, or else the analog signal is derived by going through an 8-bit nonlinear D/A converter with characteristics opposite the μ-Law quantization characteristics. Details of the nonlinear quantization characteristics and of the conversion between 8-bit μ-Law data and 16-bit linear data are given in the ITU-T G.711 standard[15].

When the format type is μ-Law (ITU-T G.711) format, the basic structure is expressed as in Figure 54 .

The two differences from PCM format are the larger size of fmt-ck (the cbSize file exists) and the existence of fact-ck.

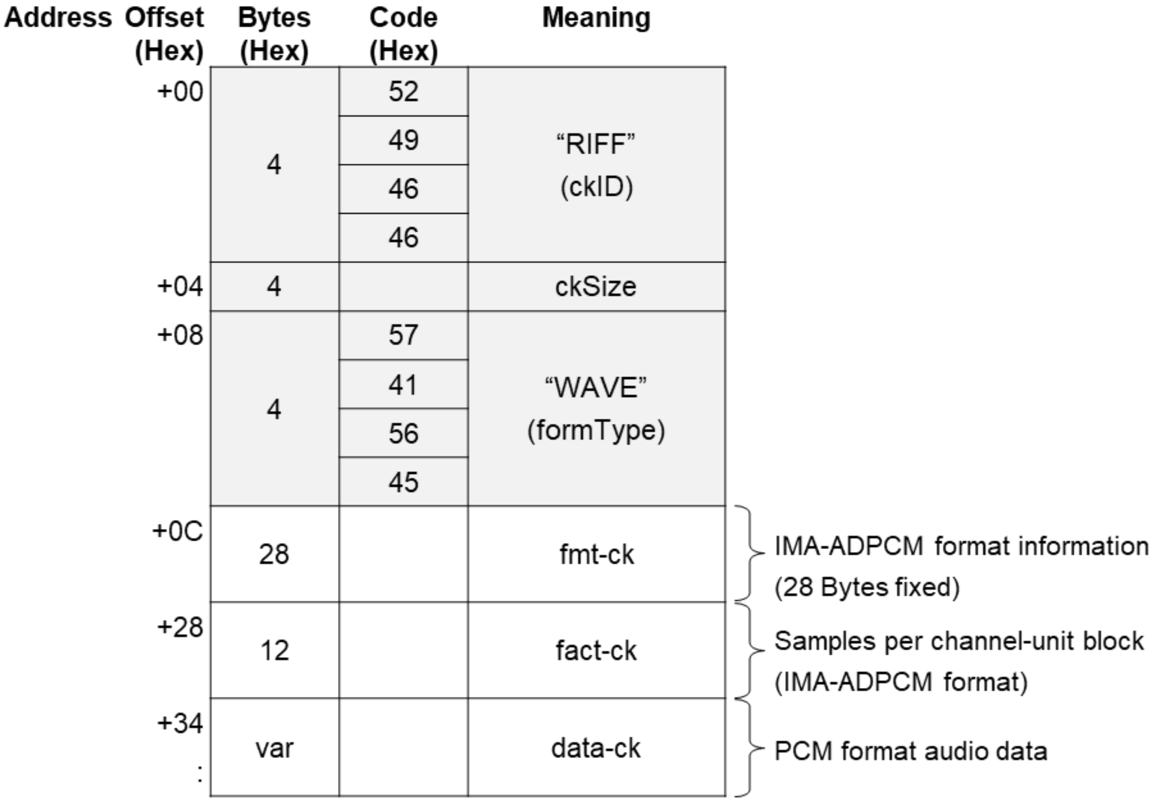


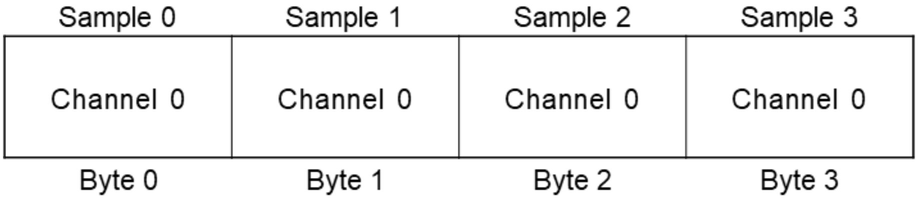
Figure 54 Basic Structure of μ-Law Format

The specific values of the information stored in fmt-ck and fact-ck in the case of the μ-Law format are given in Table 30.

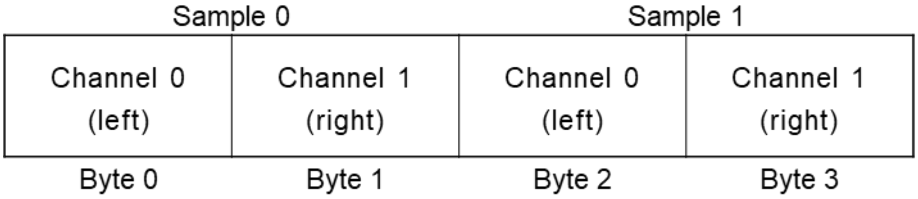
Table 30 fmt-ck and fact-ck Information in μ-Law Format

μ-Law (ITU-T G.711) Format	
Members	**Code**
ckSize(fmt-ck)	00000012.H (18Bytes, WAVEFORMATEX only)
wFormatTag	0007.H (μ-Law format)
nChannels	The values of each mode are as follows. 0001.H (monaural) or 0002.H (stereo)
nSamplesPerSec	00001F40.H (8.000KHz)
nAvgBytesPerSec	The values of each mode are as follows. 00001F40.H (8.000KHz, 8-bit monaural) 00003E80.H (8.000KHz, 8-bit stereo) Definition: `nSamplesPerSec * nBlockAlign`
nBlockAlign	The values of each mode are as follows. 0001.H (8bit monaural) 0002.H (8bit stereo) Definition: `nChannels * wBitsPerSample / 8`
wBitsPerSample	0008.H (8bit)
cbSize	0000.H (extByte[cbSize] does not exist)
extByte[cbSize]	Not used
dwSampleLength	It is recommended that the actual number of samples that can be played be recorded here. Definition: `(ckSize_of_data-ck) / nBlockAlign`

The μ-Law audio data contained in data-ck is packed as shown in Figure 55. Here the left-hand bytestores the lower address and the right-hand byte holds the upper address.



(a) μ-Law monaural



(b) μ-Law monaural

Figure 55 Packing of μ-Law Audio Data

5.5.4. Basic Structure of IMA-ADPCM Audio Data

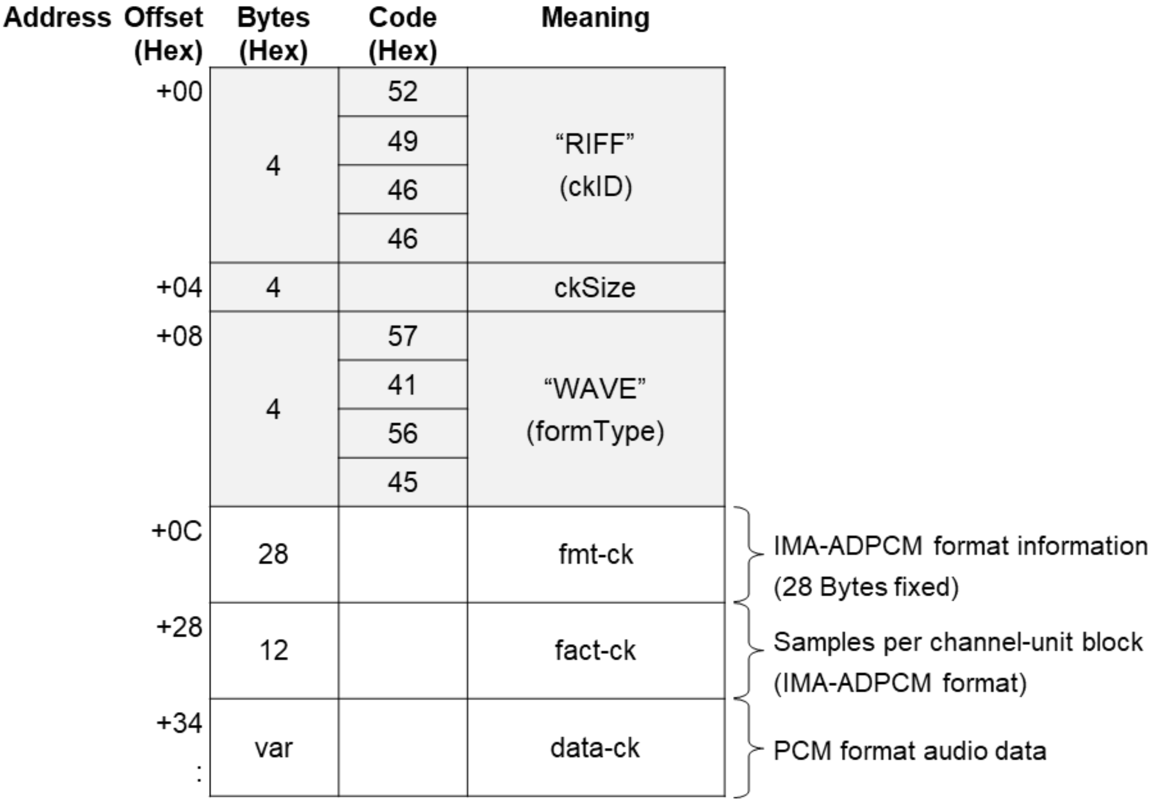
IMA-ADPCM audio data is 4-bit data obtained by compressing 16-bit linear PCM audio data.

IMA-ADPCM, as seen in its other name DVI-ADPCM, uses a compression algorithm originally developed by the Intel DVI Group (DVI: Digital Video Interactive). It was later adopted by the IMA (Interactive Multimedia Association) as a standard audio data format.

Details of the IMA-ADPCM algorithm are given in the IMA Digital Audio Doc-Pac and other documents.

When the format type is IMA-ADPCM (DVI-ADPCM)[25], the basic structure is as shown in Figure 56.

A fact-ck is recorded as with the μ-Law format, but a difference from that format is the larger fmt-ck size (in addition to a cbSize field there is a wSamplesPerBlock field).



Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	4	52	"RIFF" (ckID)
		49	
		46	
		46	
+04	4		ckSize
+08	4	57	"WAVE" (formType)
		41	
		56	
		45	
+0C	28		fmt-ck
+28	12		fact-ck
+34 :	var		data-ck

Figure 56 Basic Structure of IMA-ADPCM Format

The specific values of the information stored in fmt-ck and fact-ck in the case of the IMA-ADPCM format are given in Table 31 and Table 32.

Table 31 IMA-ADPCM Format fmt-ck and fact-ck Information (1)

IMA-ADPCM (DVI-ADPCM) Format	
Members	**Code**
ckSize(fmt-ck)	00000014.H (20 Bytes)
wFormatTag	0011.H (IMA-ADPCM format)
nChannels	0001.H (monaural) or 0002.H (stereo)
nSamplesPerSec	The values of each mode are as follows. 00001F40.H (8.000KHz) 00002B11.H (11.025 KHz) 00005622.H (22.050 KHz) 0000AC44.H (44.100KHz)

nAvgBytesPerSec	The values of each mode are as follows. 00000FD7.H (8.000KHz, 4-bit monaural) 00001FAE.H (8.000KHz, 4-bit stereo) 000015D4.H (11.025 KHz, 4-bit monaural) 00002BA9.H (11.025 KHz, 4-bit stereo) 00002B5C.H (22.050KHz, 4-bit monaural) 000056B9.H (22.050KHz, 4-bit stereo) 0000566D.H (44.100KHz, 4-bit monaural) 0000ACDB.H (44.100KHz, 4-bit stereo) Definition: `nSamplesPerSec*nBlockAlign / wSamplesPerBlock`

nBlockAlign	The values of each mode are as follows.
	0100.H (8.000KHz, 4-bit monaural)
	0200.H (8.000KHz, 4-bit stereo)
	0100.H (11.025 KHz, 4-bit monaural)
	0200.H (11.025 KHz, 4-bit stereo)
	0200.H (22.050KHz, 4-bit monaural)
	0400.H (22.050KHz, 4-bit stereo)
	0400.H (44.100KHz, 4-bit monaural)
	0800.H (44.100KHz, 4-bit stereo)
	Although the definition is `(N+1) * 4 * nChannels`, the use of
	`256 * nChannels *`
	`max (1,nSamplesPerSec / 11.025KHz)`
	is recommended.

wBitsPerSample	0004.H (4 bits)
cbSize	0002.H

Table 32 IMA-ADPCM Format fmt-ck and fact-ck Information (2)

IMA-ADPCM (DVI-ADPCM) Format	
Members	**Code**

extByte[cbSize]	The values of each mode are as follows.
	01F9.H (8.000KHz, 4-bit monaural)
	01F9.H (8.000KHz, 4-bit stereo)
	01F9.H (11.025 KHz, 4-bit monaural)
	01F9.H (11.025 KHz, 4 bit stereo)
	03F9.H (22.050KHz, 4-bit monaural)
	03F9.H (22.050KHz, 4-bit stereo)
	07F9.H (44.100KHz, 4-bit monaural)
	07F9.H (44.100KHz, 4-bit stereo)
	If the definition is, wSamplesPerBlock (an unsigned 16-bit integer indicating the samples per channel-unit block), and
	`X = (nBlockAlign -(4 * nChannels)) * 8`
	`Y = wBitsPerSample * nChannels`
	then,
	`wSamplesPerBlock =(X/Y)+1`

dwSampleLength	It is recommended that the actual number of samples that can be played back be recorded.
	The definition is as follows.
	If
	`X = ckSize_of_data-ck/nBlockAlign`
	then,
	`dwSampleLength = (X+1) * wSamplesPerBlock`

The IMA-ADPCM audio data contained in data-ck is packed as shown in Figure 57, Figure 58 and Figure 59 when it is recorded.

A feature of this format is the existence of a header at the start of each block. The header records the initial sample value for that block and a step (quantization table) index. The audio data in each channel is independent, so the number of header words is the same as the number of channels.

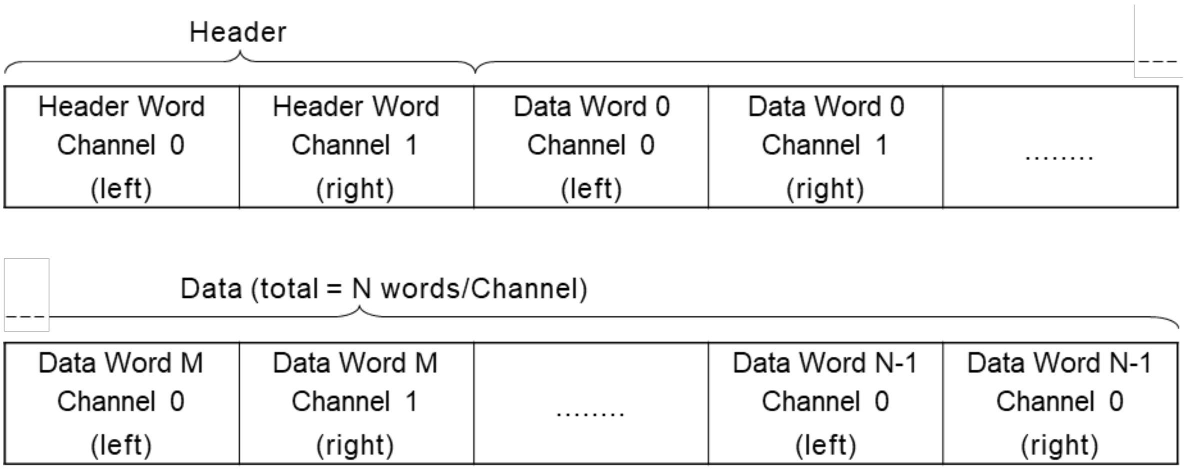
A header word consists of 4 Bytes, and is defined as in Equation 5. The existence of a header means IMA-ADPCM audio data can be played from any block. In other words, random access is possible on a per-block basis.

In Figure 57 to Figure 59, the left-hand byte stores the lower address and the right-hand byte holds the upper address.

```
typedef struct {
   signed int  iSamp0;             // Initial sample value of the block
   unsigned char  bStepTableIndex; // Step table index
   unsigned char  bReserved;       // reserved byte
} IMA_ADPCMBLOCKHEADER;      - - -[Equation 5]
```

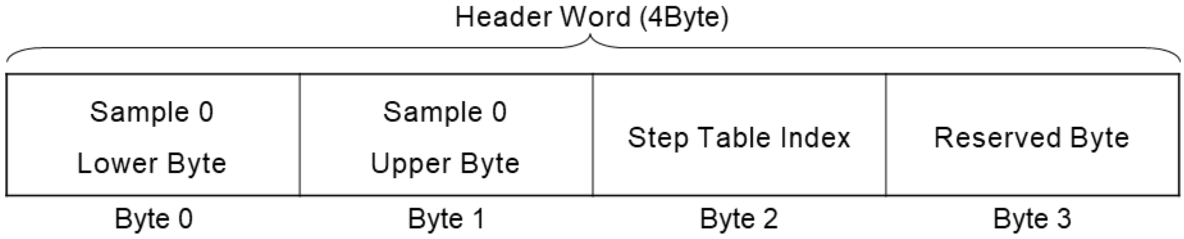
In Figure 57 to Figure 59, N, M, and P have the following significance.

```
N = (nBlockAlign/(4*nChannels)) - 1       - - -[Equation 6]
M = 0, 1, 2, 3, ....... , N-1             - - -[Equation 7]
P = ( M * 8 ) + 1                         - - -[Equation 8]
```



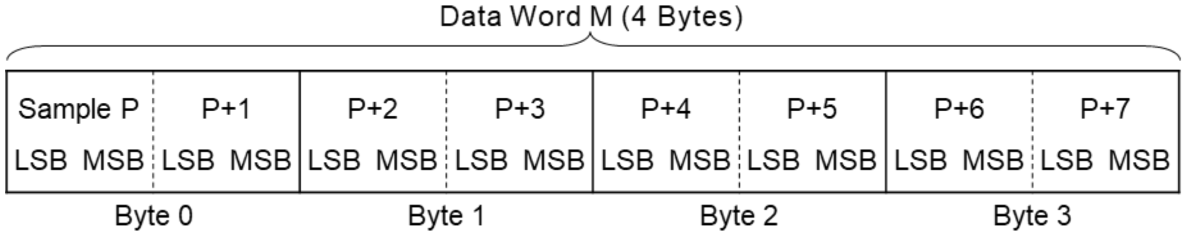
Header Word Channel 0 (left)	Header Word Channel 1 (right)	Data Word 0 Channel 0 (left)	Data Word 0 Channel 1 (right)	....
Data Word M Channel 0 (left)	Data Word M Channel 1 (right)	....	Data Word N-1 Channel 0 (left)	Data Word N-1 Channel 0 (right)

Figure 57 Packing of IMA-ADPCM Audio Data



Byte 0	Byte 1	Byte 2	Byte 3
Sample 0 Lower Byte	Sample 0 Upper Byte	Step Table Index	Reserved Byte

Figure 58 Header Word of IMA-ADPCM Audio Data



Byte 0		Byte 1		Byte 2		Byte 3	
Sample P	P+1	P+2	P+3	P+4	P+5	P+6	P+7
LSB MSB	LSB MSB	LSB MSB	LSB MSB	LSB MSB	LSB MSB	LSB MSB	LSB MSB

Figure 59 Data Word M of IMA-ADPCM Audio Data

5.6. Chunks Used

The chunks used in Exif audio files are described here.

5.6.1. WAVE Form Audio File Basic Chunks

The basic chunks of a WAVE Form Audio File, as is evident from the basic structure of the WAVE file shown in Figure 48, are the four below.

- RIFF chunk
- fmt chunk
- fact chunk
- data chunk

[Additional Explanation]

The fmt chunk, fact chunk and data chunk are sub-chunks of the RIFF chunk. A WAVE file consists of one RIFF chunk, with specific information recorded in the sub-chunks.

Only when the form type is PCM (Pulse Code Modulation) format, the fact chunk is unnecessary. With non-PCM formats such as μ-Law and IMA-ADPCM, it is mandatory, which is why fact-ck is included in the basic chunks here.

It is possible to add other optional sub-chunks as well.

At the head of the chunk data (ckData) of the RIFF chunk there is a form type called "WAVE".

5.6.2. LIST Chunk and INFO List

A WAVE form and other RIFF forms store a variety of information in sub-chunks of the RIFF chunk.

These sub-chunks in many cases are specific to each form type; but there are also general-purpose chunks for storing additional information regardless of the data specified for a given form type.

One of these general-purpose chunks is the LIST chunk. Here the use of the LIST chunk is explained.

5.6.2.1. LIST Chunk

The LIST chunk is a general-purpose chunk that may be used with the files of many different form types. The LIST chunk is a pre-registered general-purpose chunk, so its ckID (chunk ID)should be written in upper-case letters.

Included in the LIST chunk is a sub-chunk list (series of sub-chunks) and sequence designation.

The LIST chunk ckData (chunk data) consists of a four-character code at the beginning called a listType (list type), followed by the sub-chunk list.

This structure resembles that of the RIFF chunk, but the LIST chunk is always farther down the hierarchy than the RIFF chunk.

The list type is used to identify the list contents. For this reason there are list types that are used only with certain form types. If a list type that can not beinterpreted is encountered, that LIST chunk may be ignored.

The list type shall be registered. A general-purpose list type that is registered and should be used with various form types is written in all upper-case letters.

A list type that can be used only with a specific form type is written in lower-case letters.

The LIST chunk structure is illustrated in Figure 60.

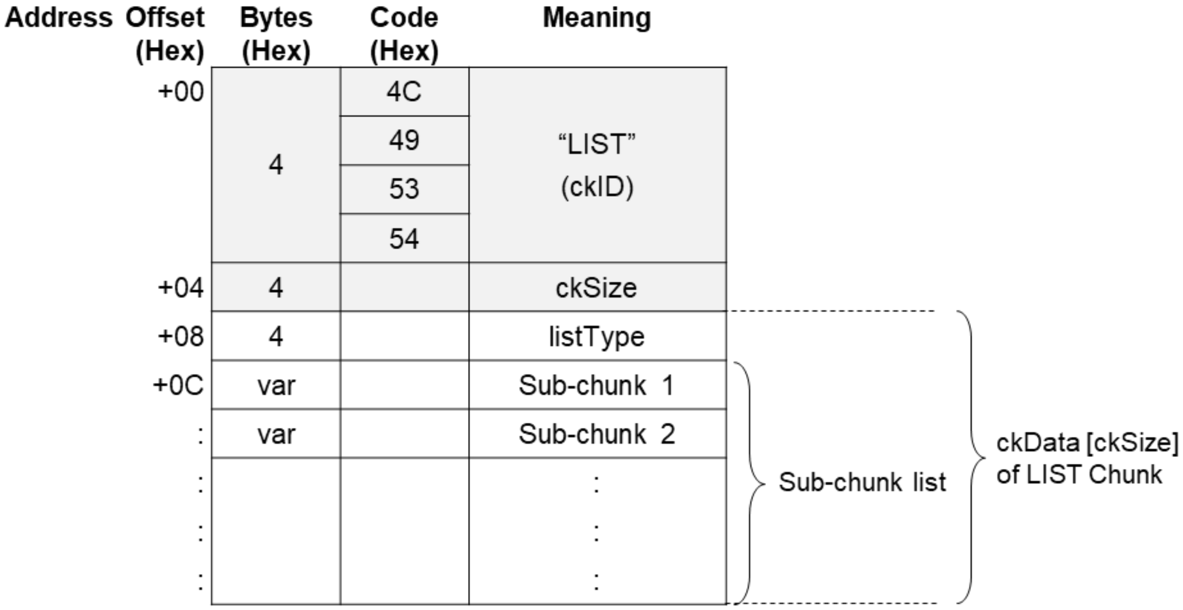


Figure 60 LIST Chunk Structure

5.6.2.2. INFO List

An "INFO list" is a LIST chunk having the registered, general-purpose listType "INFO".

The need for information such as title, copyright and comments is similar in each of the form types. The INFO list is used for storing these kinds of information.

The information itself in an INFO list is stored in the sub-chunk lists. These sub-chunks use only pre-registered, general-purpose chunks, described later below.

The INFO list information is supplementary and has no influence on the interpretation of the main data, such as WAVE form audio data. It may therefore be skipped without problem. If an unknown chunk is included on the INFO list, as when a new chunk has been defined, it shall be to be ignored.

The INFO list chunks currently defined are given in Table 33. These pre-registered chunks are stored as ASCII strings terminated with NULL.

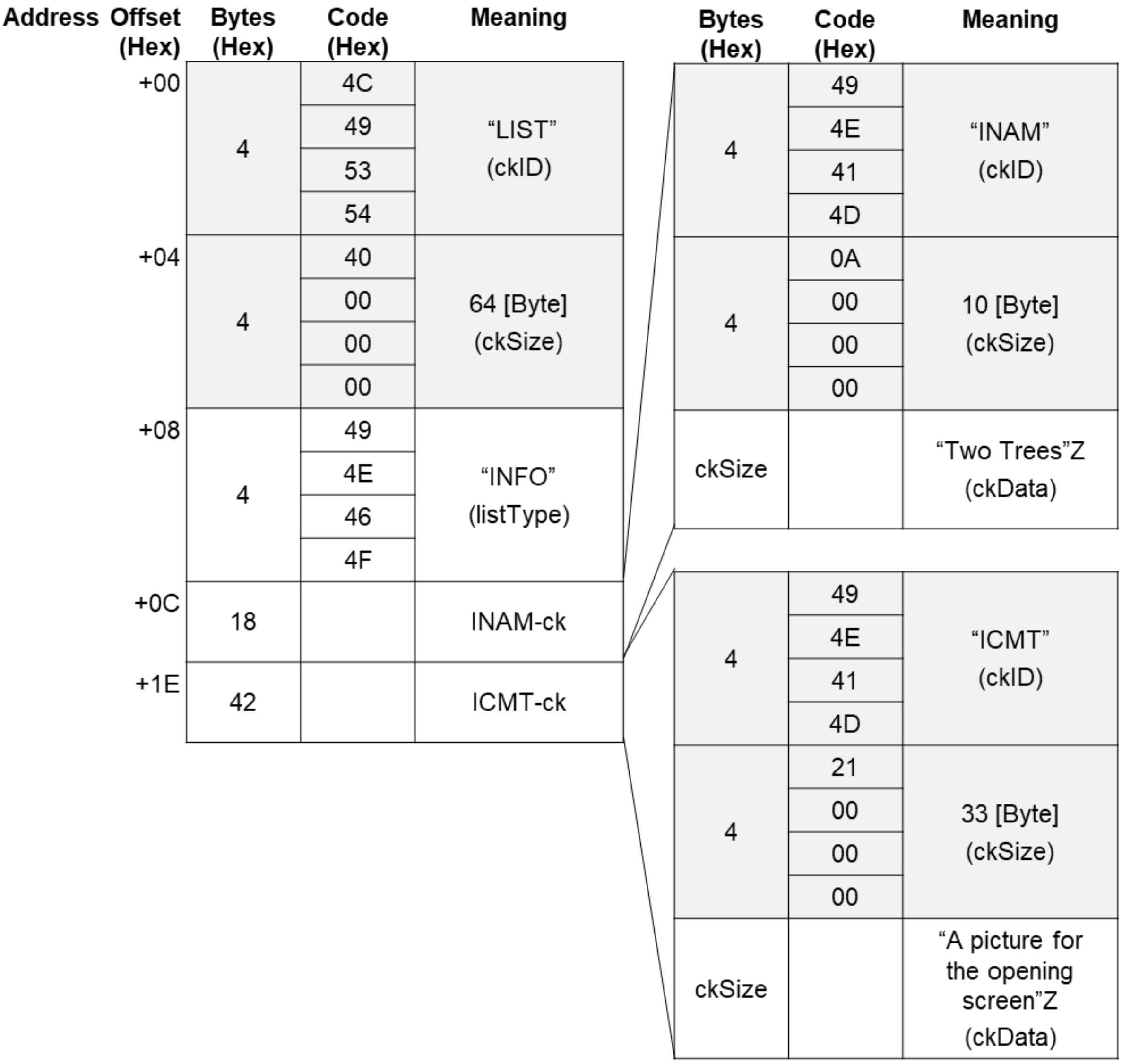
Table 33 INFO List Chunks

Chunk ID	Description
IARL	Archival Location. Indicates where the subject of the file is archived.

IART	Artist. Lists the artist of the original subject of the file.
ICMS	Commissioned. Lists the name of the person or organization that commissioned the subject of the file.
ICMT	Comments. Provides general comments about the file or the subject of the file.
ICOP	Copyright. Records the copyright information for the file.
ICRD	Creation date. Indicates the date the subject of the file was created.
ICRP	Cropped. Indicates whether an image has been cropped
IDIM	Dimensions. Specifies the size of the original subject of the file.
IDPI	Dots Per Inch (DPI). Stores the dots per inch setting of the digitizer used to produce the file.
IENG	Engineer. Stores the name of the engineer who worked on the file.
IGNR	Genre. Describes the genre of the original work.
IKEY	Keywords. Provides a list of keywords that refer to the file or subject of the file.
ILGT	Lightness. Describes the changes in lightness settings on the digitizer required to produce the file.
IMED	Medium. Describes the original subject of the file, such as, "computer image," "drawing," "lithograph," and so forth.
INAM	Name. Stores the title of the subject of the file.
IPLT	Palette Setting. Specifies the number of colors requested when digitizing an image.
IPRD	Product. Specifies the name of the title the file was originally intended for, such as "Encyclopedia of Pacific Northwest Geography."

ISBJ	Subject. Describes the file contents, such as "Aerial view of Seattle."
ISFT	Software. Identifies the name of the software package used to create the file.
ISHP	Sharpness. Identifies the changes in sharpness for the digitizer required to produce the file.
ISRC	Source. Identifies the name of the person or organization who supplied the original subject of the file.
ISRF	Source Form. Identifies the original form of the material that was digitized, such as "slide," "paper," "map," and so forth.
ITCH	Technician. Identifies the technician who digitized the subject file.

A typical INFO list is shown in Figure 61.



Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	4	4C	"LIST" (ckID)
		49	
		53	
		54	
+04	4	40	64 [Byte] (ckSize)
		00	
		00	
		00	
+08	4	49	"INFO" (listType)
		4E	
		46	
		4F	
+0C	18		INAM-ck
+1E	42		ICMT-ck

Bytes (Hex)	Code (Hex)	Meaning
4	49	"INAM" (ckID)
	4E	
	41	
	4D	
4	0A	10 [Byte] (ckSize)
	00	
	00	
	00	
ckSize		"Two Trees"Z (ckData)

Bytes (Hex)	Code (Hex)	Meaning
4	49	"ICMT" (ckID)
	4E	
	41	
	4D	
4	21	33 [Byte] (ckSize)
	00	
	00	
	00	
ckSize		"A picture for the opening screen"Z (ckData)

Figure 61 Typical INFO List

The following points need to be observed in using the INFO list. They are explained in reference to Figure 61.

- The 'Z' at the end of the text string information in the INAM and ICMT chunks means NULL termination. The actual code appended is [00.H].
- The chunk data (ckData) in each chunk shall be an even number of bytes. If the data itself is an odd number of bytes, it shall be padded by one additional byte.
- In the example in Figure 61, the ICMT chunk has 33 Bytes of information including the NULL termination, so a padding byte [00.H] shall be appended. No padding is necessary with the INAM chunk information, since the size including NULL termination is 10 Bytes.
- The value of the chunk size (ckSize) of the ICMT chunk does not include the padding byte. However, the chunk size of the LIST chunk that is its parent chunk shall include the padding bytes in the sub-chunks. If this rule is not observed, it will not be possible to determine the start address of a chunk following after this LIST chunk.

5.6.2.3. INFO List used by Exif audio files

The INFO list used with Exif audio files is as follows.

The chunks that may be included on the INFO list are those given in Table 33; but of these, only the following are used with Exif audio files.

INAM

Records the title of the Exif audio file. The title is written in an ASCII string and terminated with NULL. Recording this information is optional.

Ex.) "Exif Audio File Example"Z

IGNR

Records the genre of the Exif audio file subject. The genre name is written in an ASCII string and terminated with NULL. Recording this information is optional.

Ex.) "narration"Z

ICRD

Records the date the Exif audio file was created. It is written as a fixed-length ASCII string, in the format year-month-day. That is, the year, month, and day are separated by a hyphen. The year is four digits, while month and day are two digits each. If the number of the month or the day is less than 10, the first digit is 0. The order shall be year-month-day. Since this information is written as an ASCII string, it shall be terminated with NULL. This chunk is fixed-length (the chunk data is 11 Bytes, and a padding byte is added to make it an even byte number). Recording this information is optional.

Ex.) "1997-04-08"Z (Note: =April 8, 1997)

ICMT

Records a general comment on the Exif audio file or its subject. Comments are written in ASCII text terminated with NULL. If there are two or more comments, each statement ends with a period. A carriage return or line feed character shall not be used. Recording this information is optional.

Ex.) "Recorded by Digital Still Camera"Z

IART

Records the name of person who created the Exif audio file. The name is written in an ASCII string and terminated with NULL. Recording this information is optional.

Ex.) "Taro Yamada"Z

ICOP

Records copyright information for the Exif audio file. The copyright is written in ASCII text and terminated with NULL. In case of multiple copyright information, each is separated by a semicolon followed by one blank space [20.H]. Recording this information is optional.

Ex.) "Copyright Exif Corporation 1997."Z

[Notes and Additional Information]

- A camera shall not record chunks other than those listed above.
- If a camera encounters an unknown chunk when reading the INFO list, it shall skip that chunk. It is possible that the INFO list will be expanded in the future, and this provision ensures that compatibility will be maintained.
- Information shall be recorded in accord with the general INFO list stipulations.
- All the information on the INFO list is optional, and does not have to be recorded.
- The INFO list used for Exif audio files consists of pre-registered, general-purpose chunks only, which means this information can be read by commercial "RIFF Form Reader" software (such as the utility software provided with Windows(tm)).

5.6.3. Chunks for Attribute Information Specific to Exif Audio Files

Recording of attribute information specific to Exif audio files is done as follows.

Exif-specific attributes are those not defined for ordinary WAVE Form Audio Files but only for Exif audio files. This is auxiliary information with no influence on interpretation of the audio data itself. For this reason an Exif audio file can still be compatible with a standard WAVE Form Audio File.

The attributes specific to Exif audio files are recorded as follows.

1. LIST chunk is used.
   The compatibility noted above is realized by using a pre-registered, general-purpose LIST chunk to record the attribute information specific to Exif audio files. Since it may be used with all the LIST chunk form types, this chunk may be put in the WAVE Form Audio File. The individual information is recorded in sub-chunks of the LIST chunk.
2. A dedicated list type "exif" is defined.
   The information in the LIST chunk is explicitly labeled as information specific to Exif audio files by defining a dedicated list type. The following is used as this list type.
   - Dedicated Exif list type: "exif" (all lower-case letters)

   The attributes specific to Exif audio files can not be used in the WAVE Form Audio File format, so it is all written in lower-case letters.

   Hereafter, the notation "exif list" is used to mean the LIST chunk whose list type is exif.
3. A dedicated chunk is defined for each of the attributes.
   Since there are no corresponding existing chunks, a dedicated chunk is defined to record the attribute information specific to Exif audio files. The information items and their chunks are described below.

ever

Records the version information (number) of this standard.

As with Exif image files, it is recorded in 4 Bytes. The address bytes are recorded as A1, A2, B1, B2, starting with the lowest number. A1 and A2 store the upper part of the standard version, with the lower part stored in B1 and B2. A1, A2, B1 and B2 are ASCII numerals giving the version number, but NULL termination is unnecessary. This chunk is mandatory.

On the conventions for version number updating, see section 5.2.

Ex.) "0300" (Version 3.0)

erel

Records information pointing to an Exif image file related to the Exif audio file recorded in this chunk. Recording this information makes it possible for a camera or application software to map an image to sound during playback.

The relational information consists of the name of the corresponding Exif image file, given as an 8-character file name plus 3-character extension in ASCII format. The path is not written. Stipulations on images are given in section 4.6.6.5. File naming rules are covered in section 4.8.3.

The mapping of Exif image files and audio files is done in any of the three ways shown in Table 34. If multiple files are mapped to one file as in [2] or [3] of Table 34, the above format is used to record just one destination file name. If there are multiple destination files, the first recorded file is given.

In the case of [2] in Table 34, for the Exif audio file "SND00001.WAV" only "DSC00001.JPG" is given as the related image file. When there are three Exif image files "DSC00001.JPG," "DSC00002.JPG" and "DSC00003.JPG," the related Exif audio file name for each of them, "SND00001.WAV," is indicated. By combining multiple relational information, a variety of playback possibilities can be supported. The method of using relational information is left to the implementation on the playback side. Since this information is an ASCII character string, it is terminated with NULL. If there is a related Exif image file, this chunk is mandatory.

Ex.) "DSC00001.JPG"Z

Table 34 Mapping between Image and Audio Files

Relationship	Exif Image File	Exif Audio File
[1] 1 to 1	DSC00001.JPG	SND00001.WAV
[2] Plural to 1	DSC00001.JPG DSC00002.JPG DSC00003.JPG	SND00001.WAV
[3] 1 to Plural	DSC00001.JPG	SND00001.WAV SND00002.WAV SND00003.WAV

etim

Records the time of Exif audio file creation. This is defined as the time the recording of audio data was started. Time is expressed as a variable-length ASCII string. In order to conform as closely as possible to the Exif image file, time is recorded in the format "hour:minute:second.sub-second," with a colon in between each time unit and a period before the sub-second position.

Hour, minute and second are written as two digits each, with the first digit a zero if the value is one digit. Sub-seconds may be expressed to any desired decimal place. If there is no sub-second information, the string ends with a period only.

The order of time units is hour, minute, second, sub-second. The information is written as an ASCII string, so it shall be terminated with NULL. Recording this information is optional.

Ex.) "10:05:10.130"Z

ecor

Records the name of the manufacturer of the equipment on which the Exif audio file was created.

The manufacturer name shall be written in an ASCII string and terminated with NULL. Recording this information is optional.

Ex.) "Digital Still Camera Corporation"Z

emdl

Records the model name of the equipment on which the Exif audio file was created. The model name shall be written in an ASCII string and terminated with NULL. Recording this information is optional.

Ex.) "DSCamera1000"Z

emnt

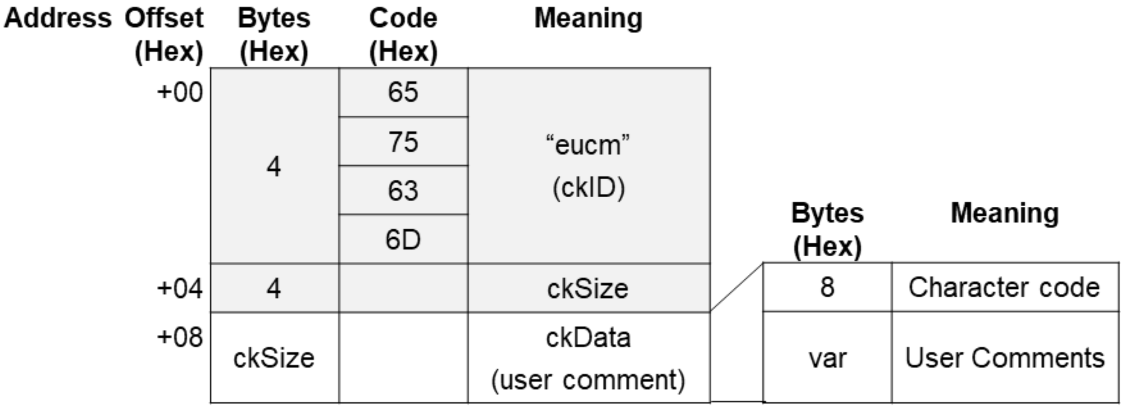
As with Exif image files, this chunk is used by the Exif/DCF writer manufacturer to record design information, version history and other maker-specific information. The contents and format of the information are up to each manufacturer. Other manufacturers see this information only as a byte array of the size determined by the chunk size (ckSize).

Recording this information is optional.

eucm

Records user comment information that can not be recorded on, or is not suitable for, the INFO list. Basically this is text information. Character code information is included so languages that do not use ASCII may be used here. Recording this chunk is optional.

Recording of user comments is discussed below. The structure of the user comment chunk is shown in Figure 62.



Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	4	65	"eucm" (ckID)
		75	
		63	
		6D	
+04	4		ckSize
+08	ckSize		ckData (user comment)

Bytes (Hex)	Meaning
8	Character code
var	User Comments

Figure 62 Structure of User Comment Chunk

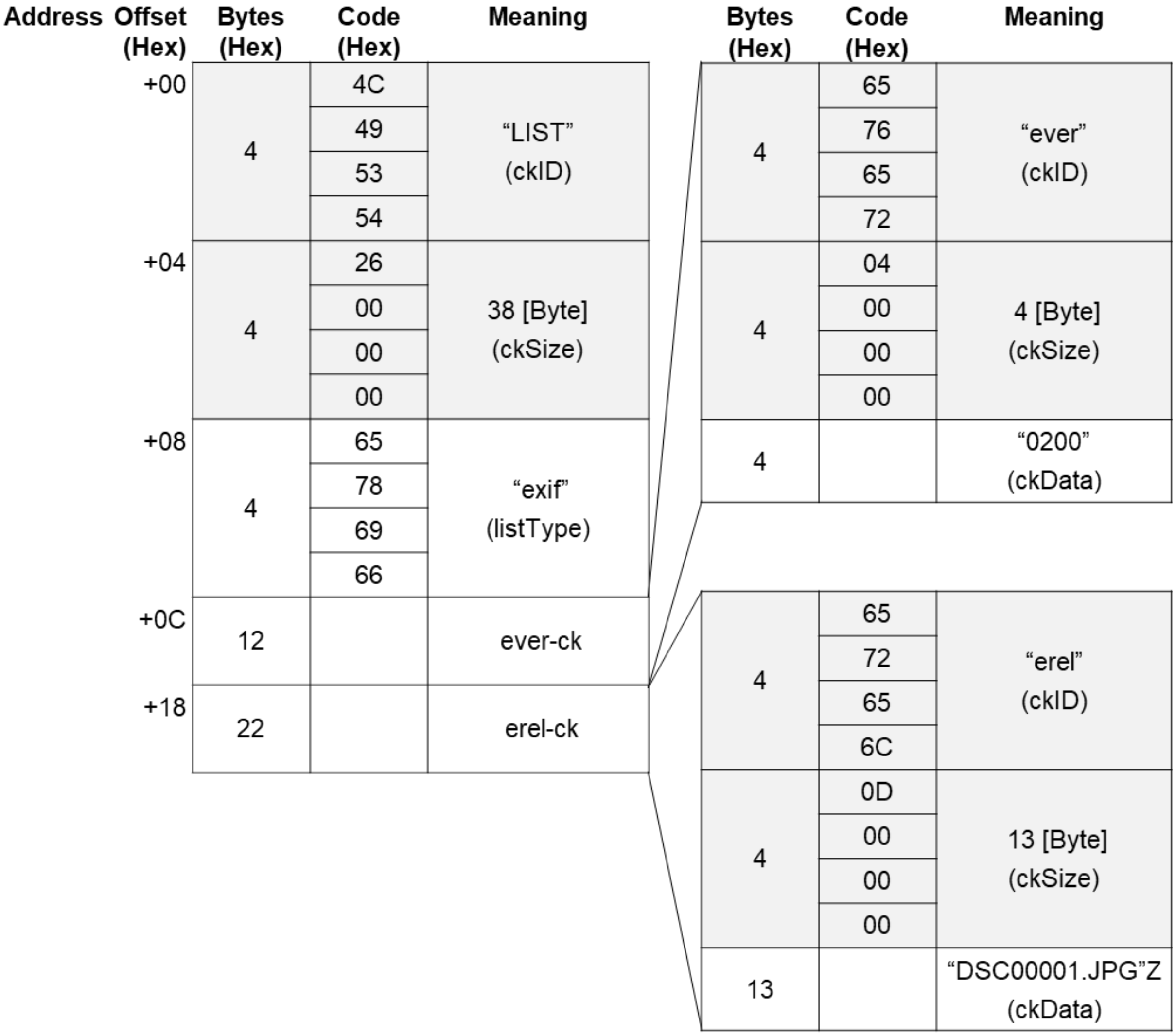
As seen in Figure 62, the chunk data area storing the user comment starts with an 8-byte character code area, where the character identifier code is given. The rest of the chunk data area is the user comment area, used for writing comments. See section 4.6.4 for character identifier code.

In order to match the format of the actual comments in the user comment part to that of the Exif image file UserComment tag, NULL termination is not used even if the comment is written in ASCII text. In accord with the chunk specification, however, a padding byte [00.H] shall be used if the chunk data is not an even number of bytes.

[Notes and Additional Information]

- The above chunks incorporated in exif list are used with a specific form type ('WAVE') and are therefore written in all lower-case letters.
- Only the ever chunk is mandatory; the others are optional. If an Exif image file related to an audio file exists, the erel chunk is also mandatory.
- When the exif list is read by a camera, information that can not be recognized may be encountered, such as the emnt chunk or an Undefined string in the eucm chunk. In that case the chunk shall be skipped.
- An Exif/DCF reader and writer shall conform to the stipulations for an ordinary LIST chunk.

- A general-purpose RIFF Form Reader will ignore the exif list. A dedicated Exif/DCF reader is required for reading the exif list.
- The Figure 63 shows the exif list structure and a coding example. The ever chunk is mandatory and has a fixed length (chunk data is 4 Bytes). The erel chunk data is 13 Bytes (odd), so a padding byte is added. The erel chunk is also fixed length.



Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	4	4C	"LIST" (ckID)
		49	
		53	
		54	
+04	4	26	38 [Byte] (ckSize)
		00	
		00	
		00	
+08	4	65	"exif" (listType)
		78	
		69	
		66	
+0C	12		ever-ck
+18	22		erel-ck

Bytes (Hex)	Code (Hex)	Meaning
4	65	"ever" (ckID)
	76	
	65	
	72	
4	04	4 [Byte] (ckSize)
	00	
	00	
	00	
4		"0200" (ckData)

Bytes (Hex)	Code (Hex)	Meaning
4	65	"erel" (ckID)
	72	
	65	
	6C	
4	0D	13 [Byte] (ckSize)
	00	
	00	
	00	
13		"DSC00001.JPG"Z (ckData)

Figure 63 exif List Structure and Typical Coding

5.7. Data Description

5.7.1. File Naming Stipulation

The file name and characters used for file names are not specified, other than to stipulate the use of ASCII alphanumerics. (File names in Japanese or other character sets are not to be used.) File names shall be 8 characters or fewer, not including the extension. (Long file names are not to be used.) The file extension is ".WAV" (to match the WAVE Form Audio File extension) regardless of the audio data format type.

5.7.2. Typical Exif Audio File

Typical Exif Audio File Figure 64 shows the configuration of a typical Exif audio file.

The shaded parts of Figure 64 are the mandatory elements of an Exif audio file. The hatching (fact-ck only) means that this chunk is not required if the audio data is PCM (Pulse Code Modulation) format, but is mandatory for all non-PCM formats (μ-Law, IMA-ADPCM), etc. The non-shaded elements are optional.

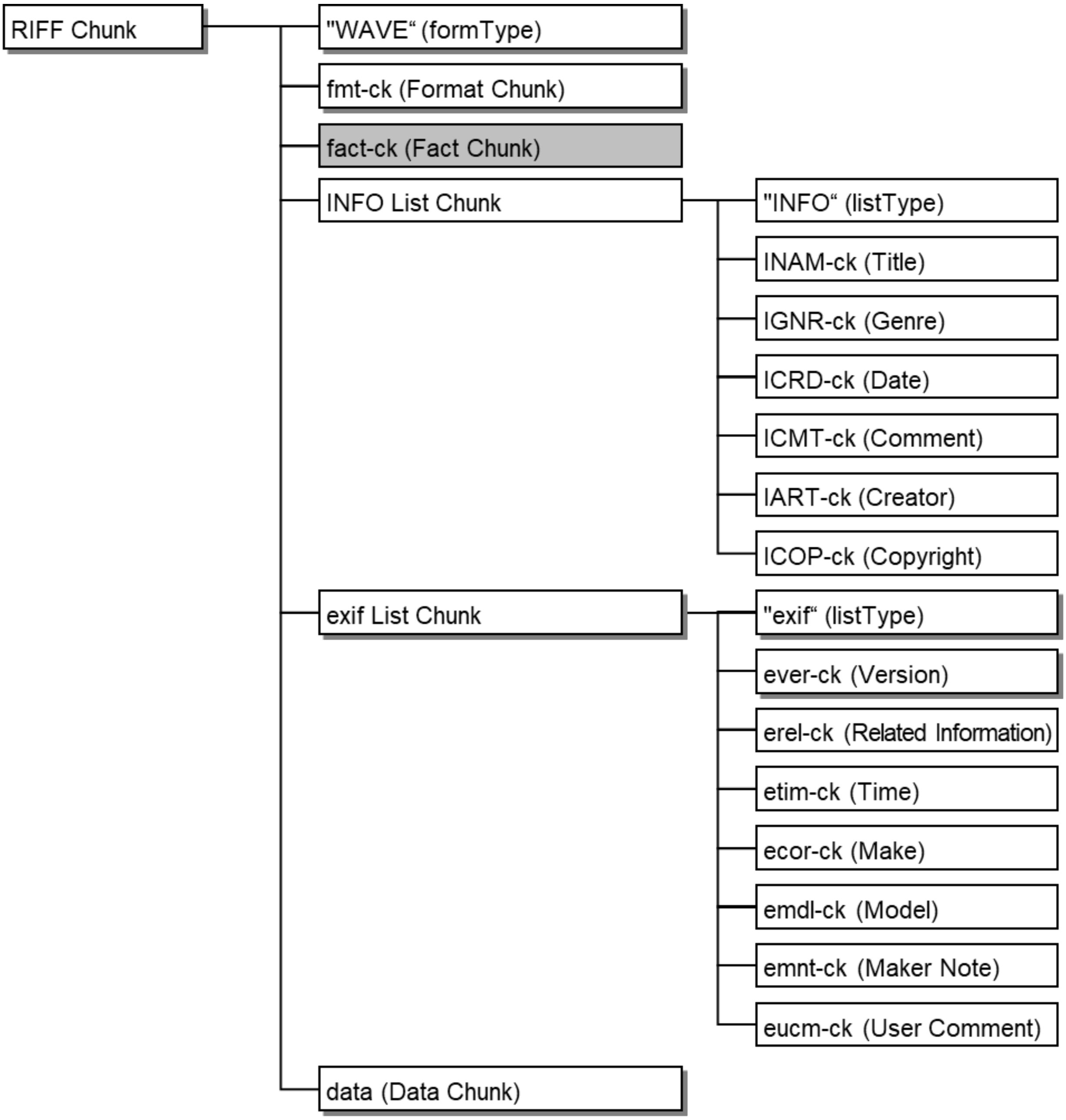
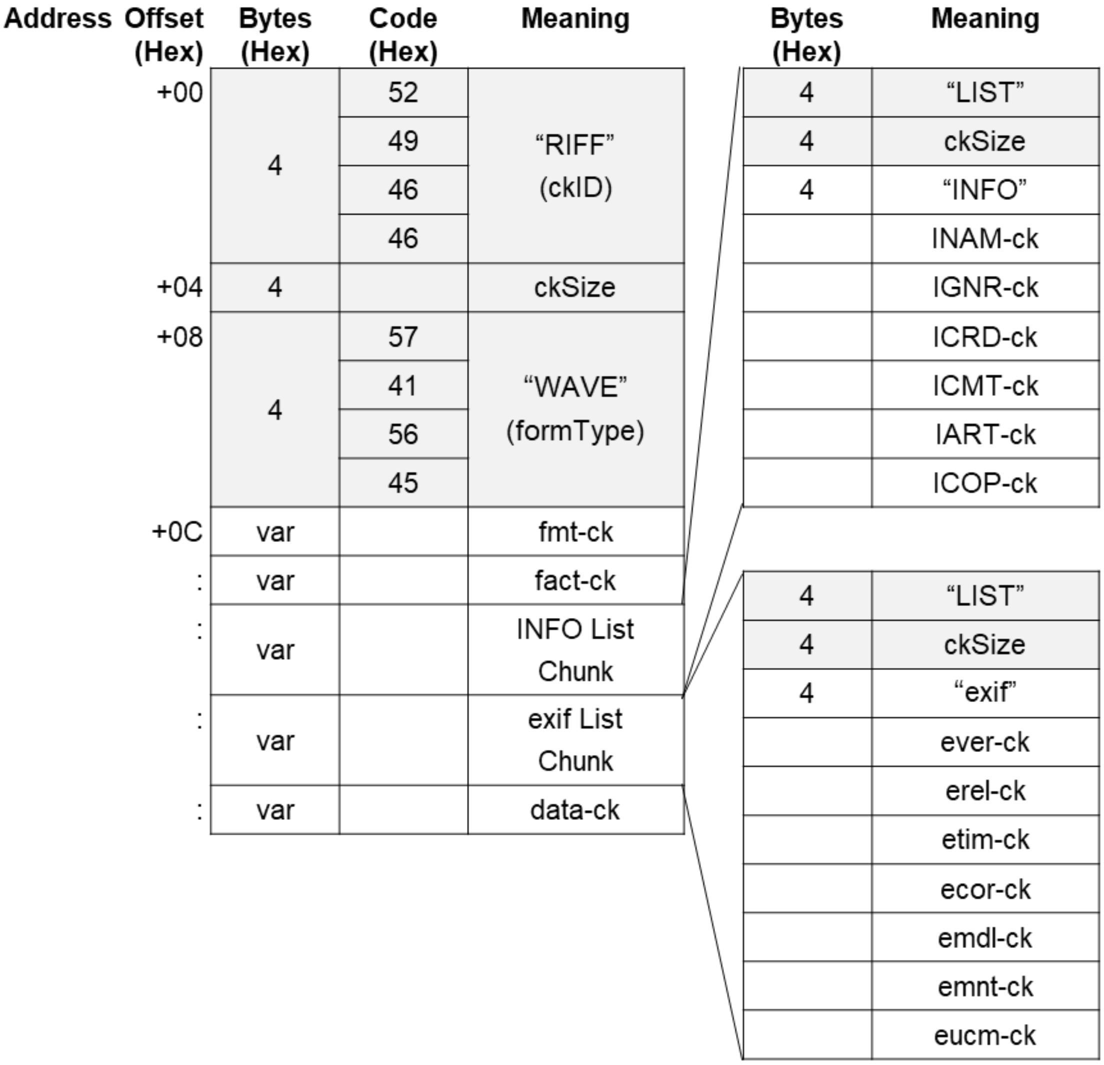


Figure 64 Exif Audio File Configuration

The means of recording the data of each element is given in the section for that element.

Figure 65 shows the most common Exif audio file data structure. Exif audio file data is recorded in accord with the structure shown in Figure 65. Each sub-chunk is recorded in accord with its stipulations. Optional chunks may be omitted.



Address Offset (Hex)	Bytes (Hex)	Code (Hex)	Meaning
+00	4	52	"RIFF" (ckID)
		49	
		46	
		46	
+04	4		ckSize
+08	4	57	"WAVE" (formType)
		41	
		56	
		45	
+0C	var		fmt-ck
:	var		fact-ck
:	var		INFO List Chunk
:	var		exif List Chunk
:	var		data-ck

Bytes (Hex)	Meaning
4	"LIST"
4	ckSize
4	"INFO"
	INAM-ck
	IGNR-ck
	ICRD-ck
	ICMT-ck
	IART-ck
	ICOP-ck

Bytes (Hex)	Meaning
4	"LIST"
4	ckSize
4	"exif"
	ever-ck
	erel-ck
	etim-ck
	ecor-ck
	emdl-ck
	emnt-ck
	eucm-ck

Figure 65 Data Structure of a Typical Exif Audio File

6. Box Format Metadata

6.1. Metadata Types

This chapter describes the metadata that can be stored using the APP11 box structure described in section 4.7.5.

At this point in time, the metadata defined in this standard is as follows, and both types are optional.

For metadata specifications, see the chapter or section referenced in the table.

Table 35 Box Format Metadata

Data Type	Label (see Figure 41)	Reference
Annotation data	“Exif_AN[NULL]”	Section 6.2
Other	Reserved for future use	—

6.2. Annotation Data

6.2.1. Overview

This section defines the annotation data description method and describes the following items.

- ・Description language
- ・Describing the area
- ・Describing attached information
- ・Describing multiple data
- ・Defining a layer structure

Annotation data constitutes specifications for annotating areas of an image (including all areas) using XML or JSON (JSON-LD), which are widely used in AI and the IoT, for the purpose of description.

6.2.2. Description Language

The language used for annotation data is selected from the two description languages of XML and JSON (JSON-LD) in accordance with usage.

The following sections define the tags established in this standard. For each tag definition, the data types specified in the Type area conform to the standard data types defined in the XML and JSON standards, respectively.

6.2.3. Annotation Description Method

6.2.3.1. Configuration

The annotation data defined in this standard shall be written within the following element:

exifEX:ExifAN (Exif ANnotation metadata)

XML and JSON (JSON-LD) examples are given in Annex J.

Annotation data consists of area information inside the image and attached information of the area. The attached information consists of a tag name and a corresponding description. Figure 66 shows the annotation data configuration.

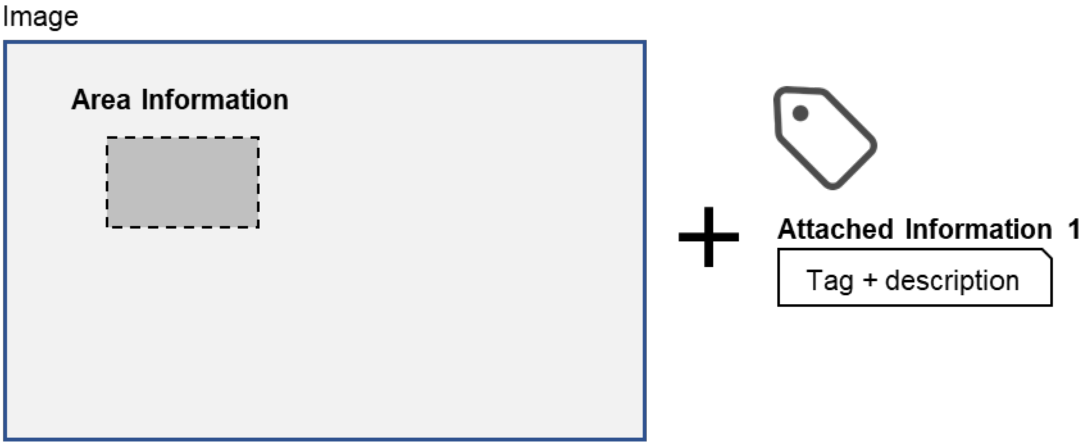


Figure 66 Annotation Data Configuration

6.2.3.2. Area

6.2.3.2.1. Position of Area

The position of the area is expressed by a horizontal position and a vertical position. With the center of the upper left corner pixel in the image direction at which the Orientation tag value is 1 as the origin of the coordinates, the value of the horizontal position is expressed as the value obtained by multiplying the horizontal reference width (hereinafter referred to as ANW: ANnotation denormalizing factor for image Width) by the value of the position normalized to 0 to 1 in the horizontal direction of the image when annotation is added. The value of the vertical position is expressed as the value obtained by multiplying the vertical reference height (hereinafter referred to ANH: ANnotation denormalizing factor for image Height) by the value of the position normalized to 0 to 1 in the vertical direction of the image when annotation is added.

As shown in Figure 67, when the image when annotation is added has the origin in the upper left of the image, the image width is IW pixels, the image height is IH pixels, and the coordinates of a point in the image are (IX, IY), the horizontal position X and the vertical position Y of the area are found by the following equations:

```
X = IX / IW * ANW

Y = IY / IH * ANH
```

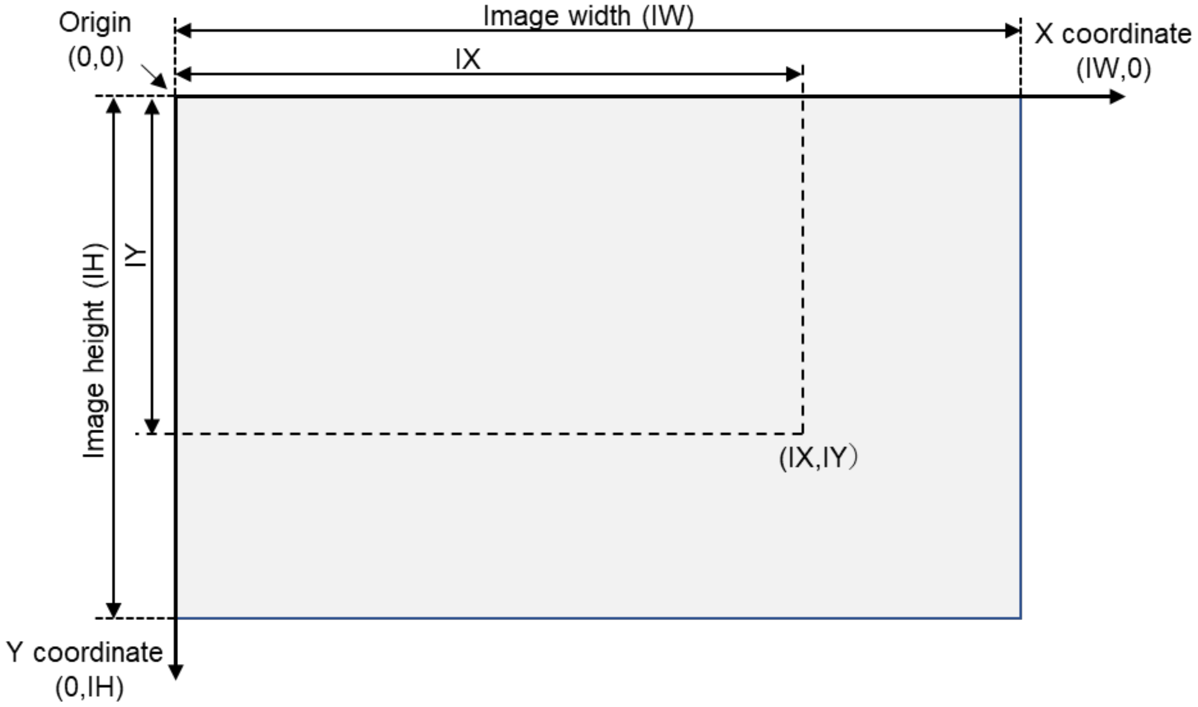


Figure 67 Position of Area of Image When Adding Annotation

The X and Y values mean the following based on the ANW and ANH values.

Table 36 ANW or ANH Value and Position Meaning

ANW or ANH Value	Position Value Meaning
1	Position normalized to 0 to 1
100	Position expressed as a percentage or position when image width (height) is 100
ANW = IW / ANH = IH	X coordinate in units of number of pixels / Y coordinate in units of number of pixels

When ANW and ANH are not written, ANW is the width of the image recorded in the JPEG marker, and ANH is the height of the image recorded in the JPEG marker.

When ANW and ANH are not written, there is a possibility of inconsistency between the position when annotation is added and the position of the JPEG image, such as when the JPEG image is resized, and thus ANW and ANH are preferably written.

6.2.3.2.2. Horizontal Reference

ANW, the width of the horizontal reference when determining the horizontal value position, is defined as follows.

Tag = XML ： exifEX:ANW

JSON(JSON-LD)： exifEX:ANW

Type = XML ： decimal

JSON(JSON-LD)： number

Count = 1

Default = Width of image recorded in JPEG marker

6.2.3.2.3. Vertical Reference

ANH, the height of the vertical reference when determining the vertical value position, is defined as follows.

Tag = XML ： exifEX:ANH

JSON(JSON-LD)： exifEX:ANH

Type = XML ： decimal

JSON(JSON-LD)： number

Count = 1

Default = Height of image recorded in JPEG marker

6.2.3.2.4. Area Types, Names, and Position Expressions

The area types are described below

Table 37 Area Types, Tag Names, and Coordinate Expressions

Area Name	Language	Area Tag Name	Attributes
Rectangle	XML	exifEX:rectangle	Expressed by upper left corner position (UX, UY) and lower right corner position (BX, BY), or upper left corner position (UX, UY) and area width W and height H
	JSON	exifEX:rectangle	
Point	XML	exifEX:multiplepoints	All point positions (X1, Y1, X2, Y2,,,,,, Xn, Yn)
	JSON	exifEX:multiplepoints	
Line	XML	exifEX:line	Expressed by all peak multipoint positions of the polygonal line
	JSON	exifEX:line	
Polygon	XML	exifEX:polygon	Expressed by all corner multipoint positions of the polygon
	JSON	exifEX:polygon	
Circle	XML	exifEX:circle	Expressed by the circle center position (CX, CY) and the radius R
	JSON	exifEX:circle	

Ellipse	XML	exifEX:ellipse	Expressed by the ellipse center position (CX, CY), long radius LR, short radius SR, and rotation angle Angle, or ellipse center position (CX, CY), long diameter L, short diameter S, and rotation angle Angle The rotation angle Angle is specified by the clockwise angle (degree) given 0 degrees as the X-axis direction
	JSON	exifEX:ellipse	
Whole image		exifEX:whole	NULL

6.2.3.2.5. Rectangle Area

The rectangle area can be specified by expressing the upper left and lower right corner positions of the rectangle, or by expressing the upper left corner position of the rectangle and the width and height of the rectangle.

When expressed by the upper left and lower right corner positions of the rectangle, the rectangle is expressed by the upper left corner position (UX, UY) and the lower right corner position (BX, BY) of the rectangle. And, when expressed by the upper left corner position of the rectangle and the width and height of the rectangle, the rectangle is expressed by the upper left corner position (UX, UY) of the rectangle and the width W and the height H of the rectangle.

UX and BX, as in X in section 6.2.3.2.1, are each expressed by a value obtained by multiplying ANW by a value of the position normalized to 0 to 1 in the horizontal direction. UY and BY are also, as in Y in section 6.2.3.2.1, each expressed by a value obtained by multiplying ANH by a value of the position normalized to 0 to 1 in the vertical direction. W is expressed by a value obtained by multiplying ANW by the value of the width of the rectangle normalized to 0 to 1 in the horizontal direction. H is expressed by a value obtained by multiplying ANH by the value of the height of the rectangle normalized to 0 to 1 in the vertical direction.

Note that a rotated rectangle can be expressed as four points of a polygon, which is simpler than rotated coordinates, and thus is not defined in this standard.

Tag = XML ：exifEX:rectangle

JSON(JSON-LD)：exifEX:rectangle

Type = XML ：decimal

JSON(JSON-LD)：number

Count = 4
Default = None

Attributes

UX: The value obtained by multiplying the horizontal reference width ANW by the horizontal position value of the upper left corner of the rectangle normalized to 0 to 1 in the horizontal direction in the image when annotation is added

UY: The value obtained by multiplying the vertical reference height ANH by the vertical position value of the upper left corner of the rectangle normalized to 0 ot 1 in the vertical direction in the image when annotation is added

BX: The value obtained by multiplying the horizontal reference width ANW by the horizontal position value of the lower right corner of the rectangle normalized to 0 to 1 in the horizontal direction in the image when annotation is added

BY: The value obtained by multiplying the vertical reference height ANH by the vertical position value of the lower right corner of the rectangle normalized to 0 ot 1 in the vertical direction in the image when annotation is added

W: The value obtained by multiplying the horizontal reference width ANW by the horizontal width value of the rectangle normalized to 0 to 1 in the horizontal direction in the image when annotation is added

H: The value obtained by multiplying the vertical reference height ANH by the vertical height value of the rectangle normalized to 0 to 1 in the vertical direction in the image when annotation is added

Example [XML] :

```
<exifEX:rectangle>
   <UX>1010</UX>
   <UY>110</UY>
   <BX>2010</BX>
   <BY>910</BY>
</exifEX:rectangle>
```

or

```
<exifEX:rectangle>
   <UX>1010</UX>
   <UY>110</UY>
   <W>1000</W>
   <H>800</H>
</exifEX:rectangle>
```

Example [JSON(JSON-LD)] :

```
“exifEX:rectangle”:{“UX”:1010,“UY”:110,“BX”:2010,“BY”:910}
```

or

```
“exifEX:rectangle”:{“UX”:1010,“UY”:110,“W”:1000,“H”:800}
```

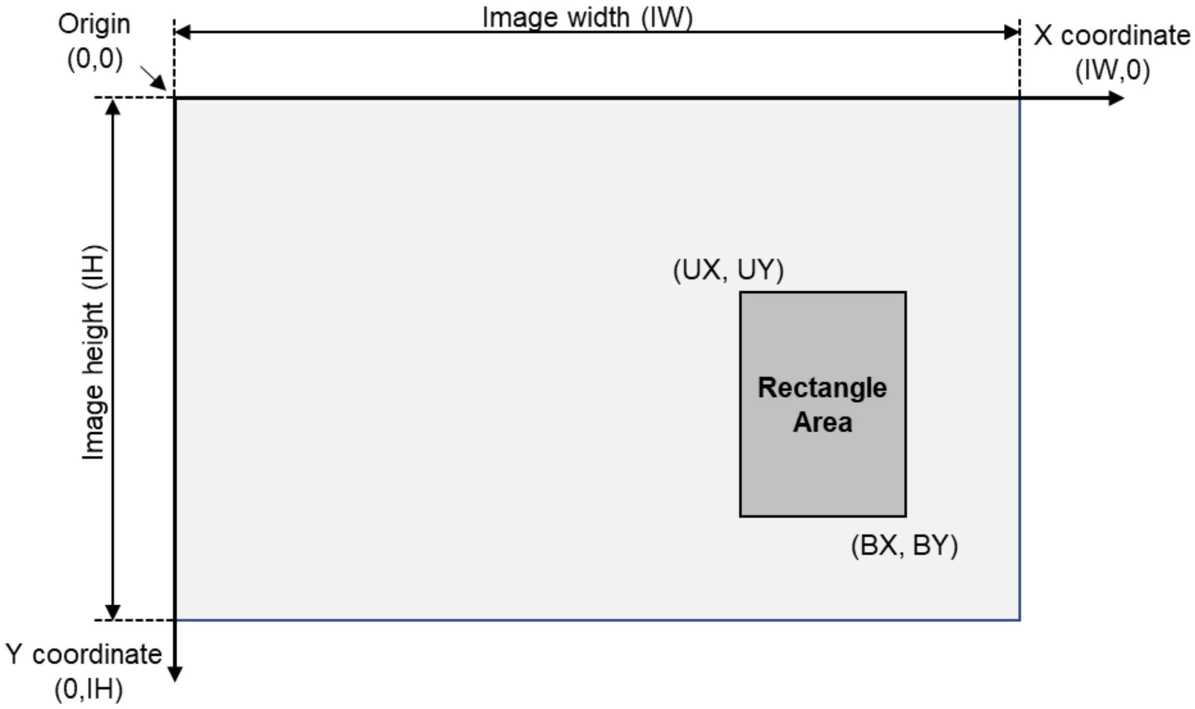


Figure 68 Rectangle Area - 1

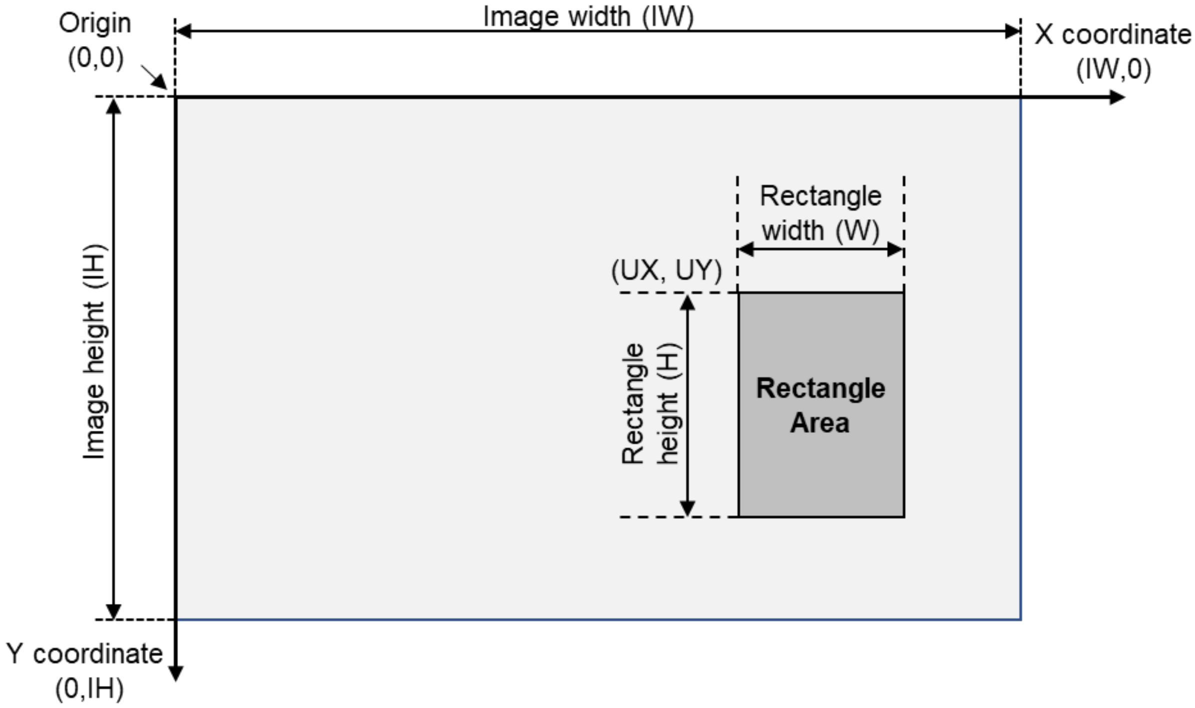


Figure 69 Rectangle Area - 2

6.2.3.2.6. Point

Point(s) are expressed by one or more sets of (X, Y) point coordinates.

X, as in X in section 6.2.3.2.1, is expressed by the value obtained by multiplying ANW by the horizontal position value of the point normalized to 0 to 1 in the horizontal direction. Y is also, as in Y in section 6.2.3.2.1, expressed by the value obtained by multiplying the ANH by the vertical position value of the point normalized to 0 to 1 in the vertical direction.

Tag = XML ： exifEX:multiplepoints
JSON(JSON-LD) ： exifEX:multiplepoints

Type = XML ： decimal
JSON(JSON-LD) ： number

Count = 2n (where n is the number of pairs of X and Y)
Default = None

Attributes

X: The value obtained by multiplying the horizontal reference value ANW by the horizontal position value of the point normalized to 0 to 1 in the horizontal direction in the image when annotation is added

Y: The value obtained by multiplying the vertical reference height ANH by the vertical position value of the point normalized to 0 to 1 in the vertical direction in the image when annotation is added

Example [XML] :

```
<exifEX:multiplepoints>
   <X>10</X>
   <Y>20</Y>
   <X>30</X>
   <Y>40</Y>
   …
</exifEX:multiplepoints>
```

Example [JSON(JSON-LD)] :

```
“exifEX:multiplepoints”:{“X”:10,”Y”:20,“X”:30,”Y”:40,,,}
```

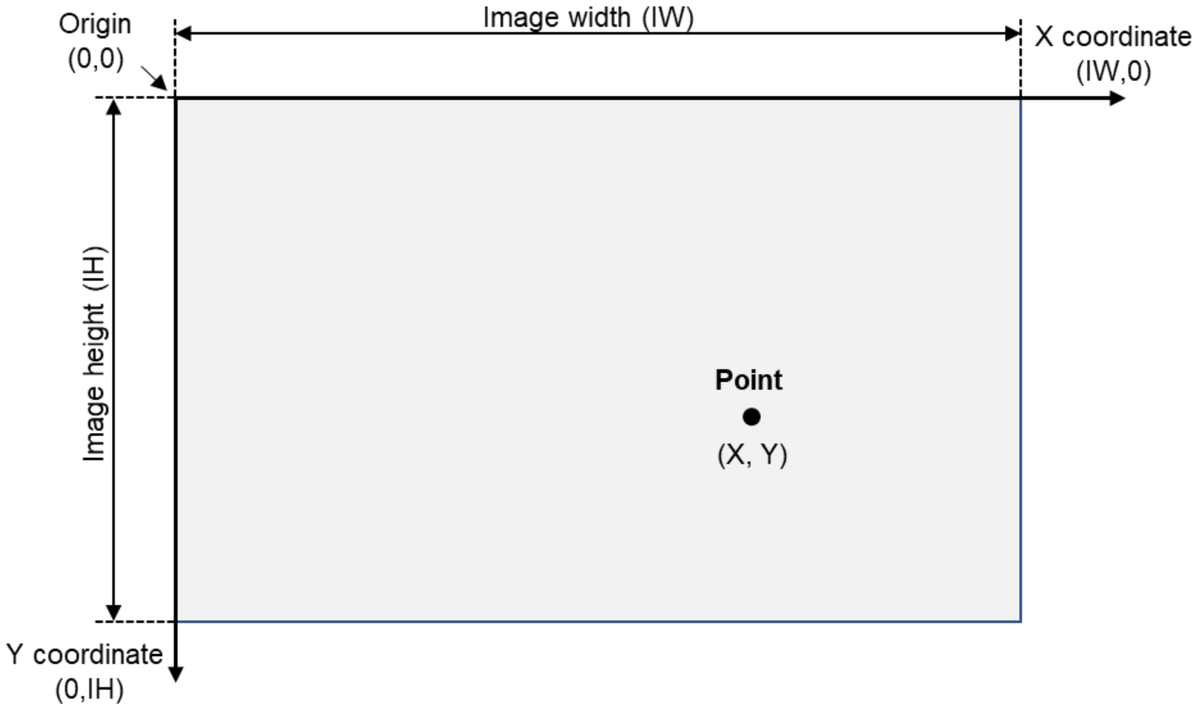


Figure 70 Point

6.2.3.2.7. Line

A line is expressed by all peak positions of the polyline. All peak positions of the polyline are expressed by point descriptions. The polyline is constituted by line segments connected in the order of the described points.

Tag = XML ： exifEX:line

JSON(JSON-LD)： exifEX:line

Type = XML ： decimal

JSON(JSON-LD)： number

Count = 2n (where n is the number of pairs of X and Y)
Default = None

Attributes

exifEX:multiplepoints

Example [XML] :

```
<exifEX:line>
    <exifEX:multiplepoints>
        <X>10</X>
        <Y>20</Y>
        <X>30</X>
        <Y>40</Y>
        …
    </exifEX:multiplepoints>
</exifEX:line>
```

Example [JSON(JSON-LD)] :

```
“exifEX:line”: {
    “exifEX:multiplepoints”:{“X”:10,”Y”:20,“X”:30,”Y”:40,,,}
}
```

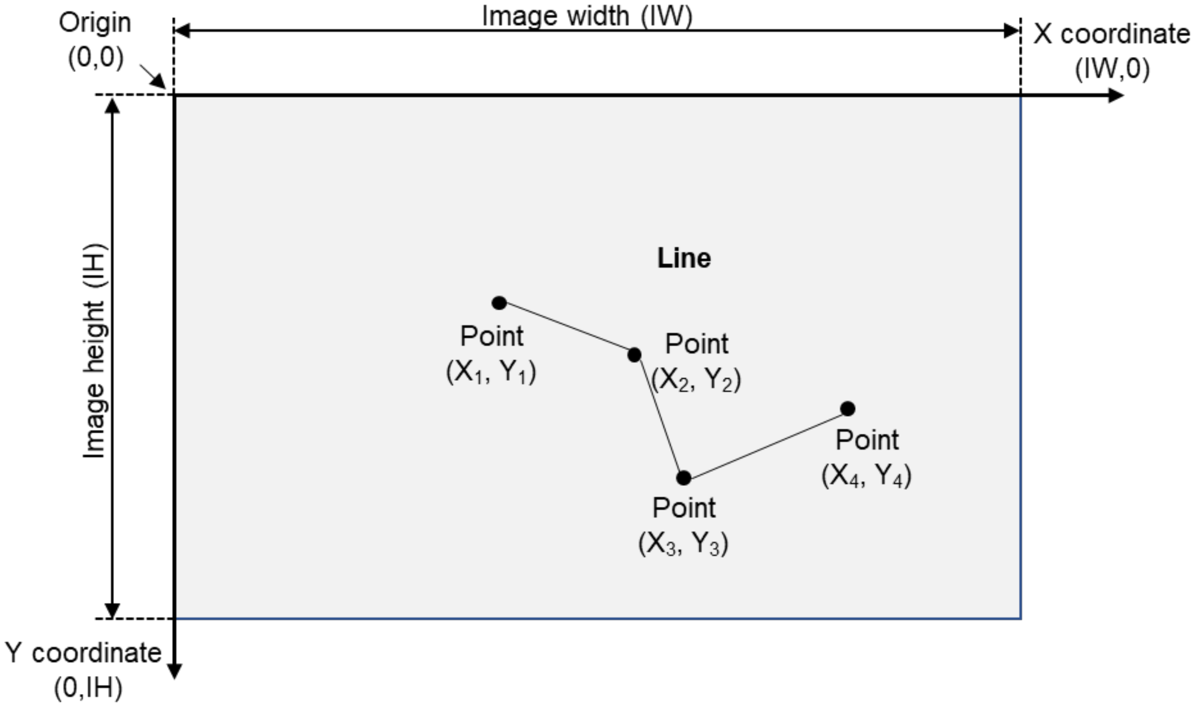


Figure 71 Line

6.2.3.2.8. Polygon Area

A polygon area is expressed by all corner positions of the polygon. All corner positions of the polygon area are expressed by point descriptions.

A polygon is constituted by closed line segments based on line segments connected in the order of the described points and a line segment connecting the point described last with the point described first.

Tag = XML ： exifEX:polygon

JSON(JSON-LD)： exifEX:polygon

Type = XML ： decimal

JSON(JSON-LD)： number

Count = 2n (where n is the number of pairs of X and Y)
Default = None

Attributes

exifEX:multiplepoints

Example [XML] :

```
<exifEX:polygon>
   <exifEX:multiplepoints>
      <X>10</X>
      <Y>20</Y>
      <X>30</X>
      <Y>40</Y>
      …
      </exifEX:multiplepoints>
</exifEX:polygon>
```

Example [JSON(JSON-LD)] :

```
“exifEX:polygon”: {
   “exifEX:multiplepoints”:{“X”:10,”Y”:20,“X”:30,”Y”:40,,,}
}
```

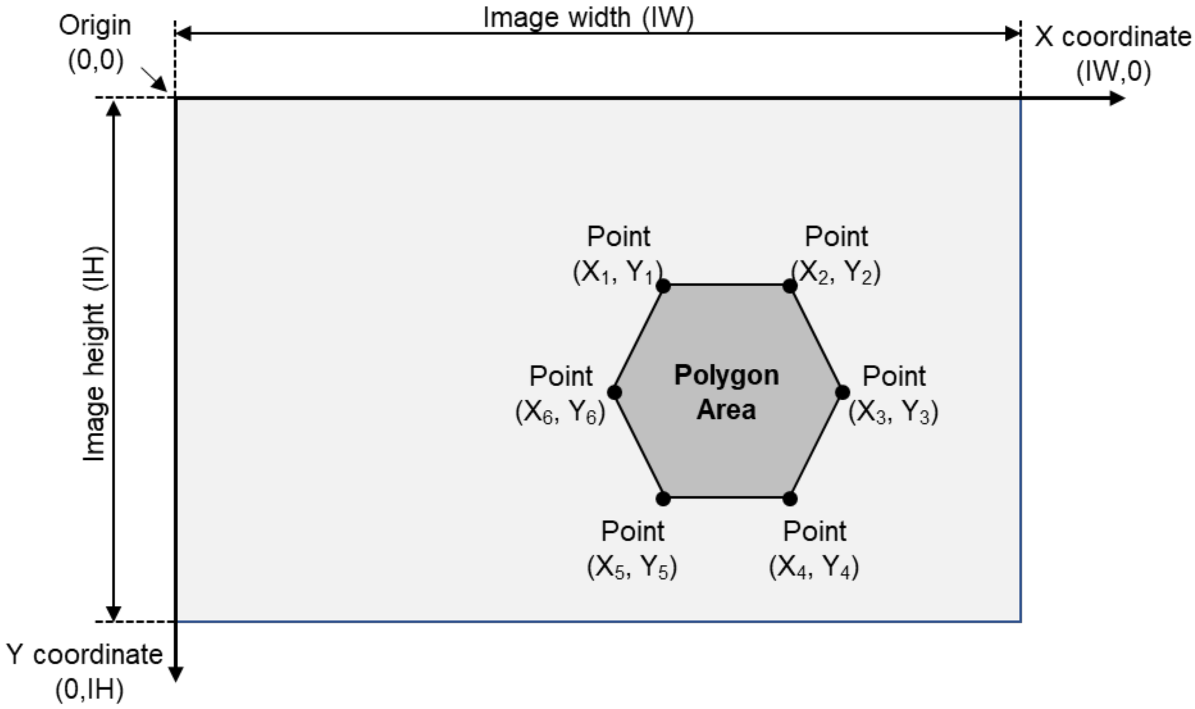


Figure 72 Polygon Area

6.2.3.2.9. Circle Area

A circle area is expressed by a circle center position (CX,CY) and a radius R.

CX, as in X in section 6.2.3.2.1, is expressed by the value obtained by multiplying ANW by the value of the position normalized to 0 to 1 in the horizontal direction. CY is also, as in Y in section 6.2.3.2.1, expressed by the value obtained by multiplying ANH by the value of the position normalized to 0 to 1 in the vertical direction. R is expressed by the value obtained by multiplying ANW by the value of the radius of the circle normalized to 0 to 1 in the horizontal direction.

Tag = XML ： exifEX:circle
JSON(JSON-LD)： exifEX:circle
Type = XML ： decimal
JSON(JSON-LD)： number
Count = 3
Default = None

Attributes

CX: The value obtained by multiplying the horizontal reference width ANW by the horizontal position value of the center point of the circle normalized to 0 to 1 in the horizontal direction in the image when annotation is added

CY: The value obtained by multiplying the vertical reference height ANH by the vertical position value of the center point of the circle normalized to 0 to 1 in the vertical direction in the image when annotation is added

R: The value obtained by multiplying the horizontal reference width ANW by the radius value of the circle normalized to 0 to 1 in the horizontal direction in the image when annotation is added

Example [XML] :

```
<exifEX:circle>
    <CX>100</CX>
    <CY>200</CY>
    <R>50</R>
</exifEX:circle >
```

Example [JSON(JSON-LD)] :

```
“exifEX:circle”:{”CX”:100,”CY”:200,”R”:50}
```

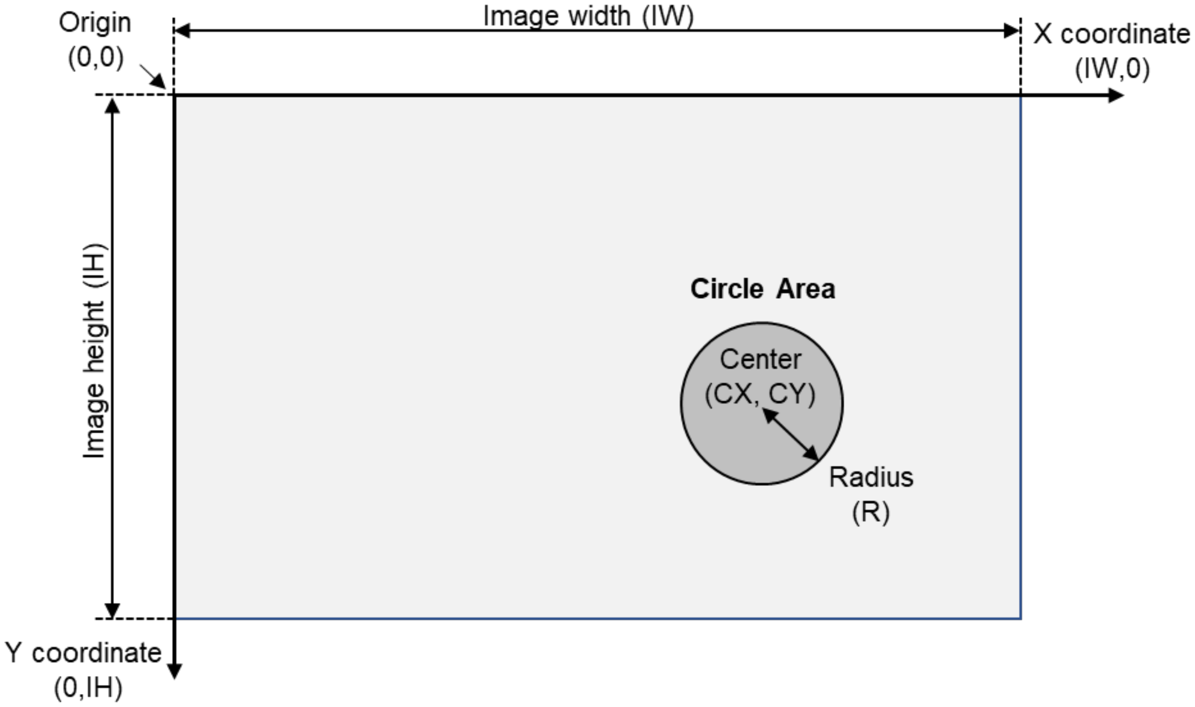


Figure 73 Circle Area

6.2.3.2.10. Ellipse Area

An ellipse area is expressed by the ellipse center position (CX, CY), long radius LR, short radius SR, and rotation angle Angle. Or, an ellipse area is expressed by the ellipse center position (CX, CY), long diameter L, short diameter S, and rotation angle Angle.

The Angle specifies the angle to the major axis in "degrees" in the clockwise direction given 0 degrees as the X axis direction.

CX, as in X in section 6.2.3.2.1, is expressed by a value obtained by multiplying ANW by the value of the ellipse center point normalized to 0 to 1 in the horizontal direction. CY also, as in Y in section 6.2.3.2.1, is expressed by a value obtained by multiplying ANH by the value of the ellipse center point normalized to 0 to 1 in the vertical direction. LR is expressed by the value obtained by multiplying ANW by the value of the ellipse long radius normalized to 0 to 1 in the horizontal direction. SR is expressed by the value obtained by multiplying ANW by the value of the ellipse short radius normalized to 0 to 1 in the horizontal direction. L is expressed by the value obtained by multiplying ANW by the value of the ellipse long diameter normalized to 0 to 1 in the horizontal direction. S is expressed by a value obtained by multiplying ANW by the value of the ellipse short diameter normalized to 0 to 1 in the horizontal direction.

Tag = XML ： exifEX:ellipse
JSON(JSON-LD) ： exifEX:ellipse
Type = XML ： decimal
JSON(JSON-LD) ： number
Count = 5
Default = None

Attributes

CX: The value obtained by multiplying the horizontal reference width ANW by the horizontal position value of the ellipse center point normalized to 0 to 1 in the horizontal direction in the image when annotation is added

CY: The value obtained by multiplying the vertical reference height ANH by the vertical position value of the ellipse center point normalized to 0 to 1 in the vertical direction in the image when annotation is added

LR: The value obtained by multiplying the horizontal reference width ANW by the value of the ellipse long radius normalized to 0 to 1 in the horizontal direction in the image when annotation is added

SR: The value obtained by multiplying the horizontal reference width ANW by the value of the ellipse short radius normalized to 0 to 1 in the horizontal direction in the image when annotation is added

L: The value obtained by multiplying the horizontal reference width ANW by the value of the ellipse long diameter normalized to 0 to 1 in the horizontal direction in the image when annotation is added

S: The value obtained by multiplying the horizontal reference width ANW by the value of the ellipse short diameter normalized to 0 to 1 in the horizontal direction in the image when annotation is added

Angle: Indicates the rotational angle of the ellipse in the image when annotation is added, and is specified by the clockwise angle (degrees) to the major axis with 0 degrees as the X axis direction

Example [XML] :

```
<exifEX:ellipse>
   <CX>100</CX>
   <CY>150</CY>
   <LR>30</LR>
   <SR>20</SR>
   <Angle>30.5</Angle>
</exifEX:ellipse>
```

Example [JSON(JSON-LD)] :

```
“exifEX:ellipse”:{“CX”:100,“CY”:150,“LR”:30,“SR”:20,“Angle”:30.5}
```

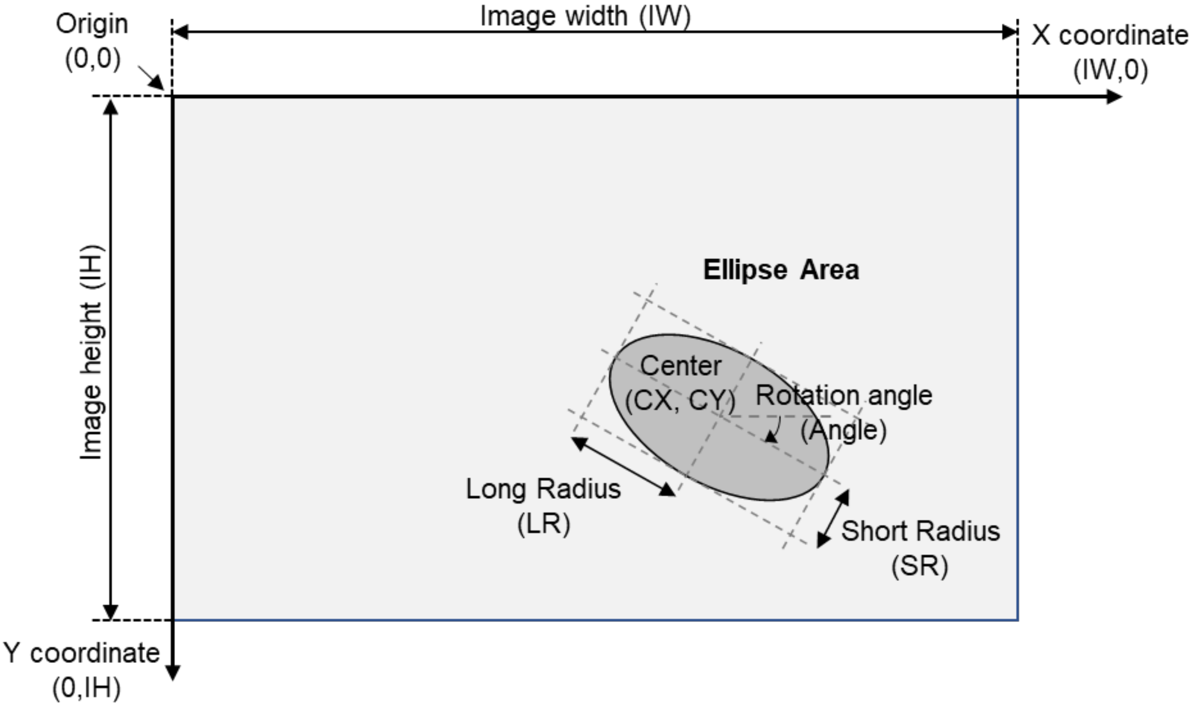


Figure 74 Ellipse Area

6.2.3.2.11. Full Image Area

The full image area indicates the entire image.

Tag = XML ： exifEX:whole

JSON(JSON-LD)： exifEX:whole

Type = None
Count = 0
Default = None

Attributes

None

Example [XML] :

```
<exifEX:whole></exifEX:whole>
```

Example [JSON(JSON-LD)] :

```
”exifEX:whole”
```

6.2.3.3. Attached Information

6.2.3.3.1. Structure of Attached Information

The structure is the tag name + content (metadata). The tag name and the content (metadata) shall be text information (including numerical values). The character code used shall be UTF-8.

The description languages are XML and JSON-LD. See the respective standards.

The written attached information can duplicate the image capturing information, etc., of the camera of the APP1 specified in this standard. When this information is written in duplicate, the contents of both entries shall be consistent.

6.2.3.3.2. Tag Name Standardization and Classification by Industry

For tag names, preferably not only the syntax but also the terminology are standardized from the viewpoint of effective utilization of annotation data across industries.

For digital camera terminology, use of the terms defined in Individual Guidelines for Noting Digital Camera Specifications on Number of Pixels, Image Files, and Focal Length of Lens (CIPA DCG-001-2018) and the Specification Guideline for Digital Cameras (CIPA DCG-002-2016) is recommended.

On the other hand, unique metadata required in each industry exists and is already specified for each industry (see Annex I). Given these circumstances, this standard specifies "terminology related to the area" which is essential to the standard configuration as tag names.

6.2.3.4. Describing Multiple Data

6.2.3.4.1. Describing Multiple Sets of Attached Information

Multiple sets of attached information can be written for one area.

・Area + (Attached information 1, Attached information 2, . . . , Attached information n)

In XML format and JSON (JSON-LD) format, the respective configurations are as follows.

Configuration of one area in XML format:

```
<region>
<Area description tag> Attribute1, Attribute2, … </Area description tag>
<Attached information tag> Content text A </Attached information tag>
<Attached information tag> Content text B </Attached information tag>
…
</region>
```

Configuration of one area in JSON (JSON-LD) format:

```
{
   Area information tag: (Atribute1, Attribute2, … },
   Attached information tag: Content text A,
   Attached information tag: Content text B,
   …
}
```

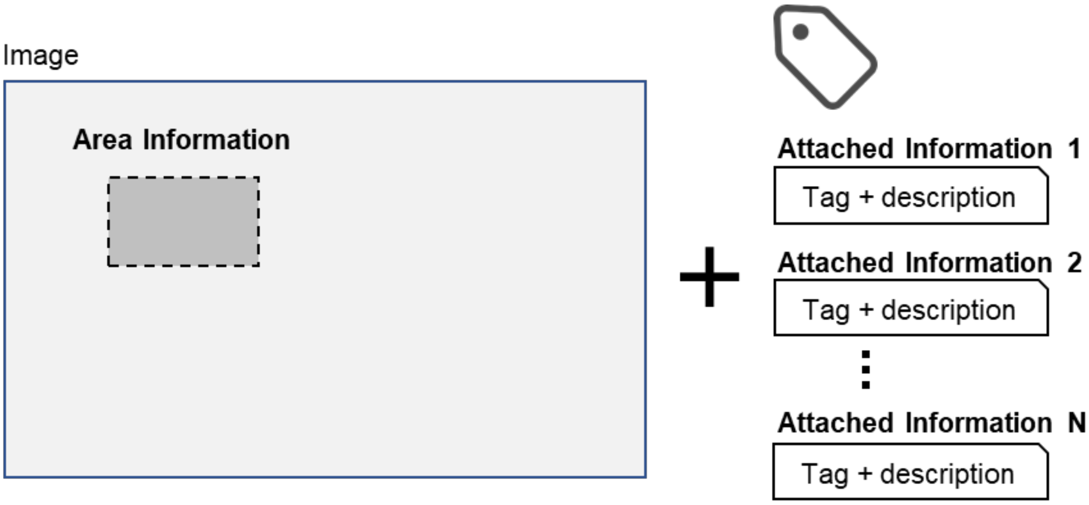


Figure 75 Describing Multiple Sets of Attached Information

6.2.3.4.2. Specifying Multiple Areas

Multiple areas can be specified within one image, and attached information can be written for each area.

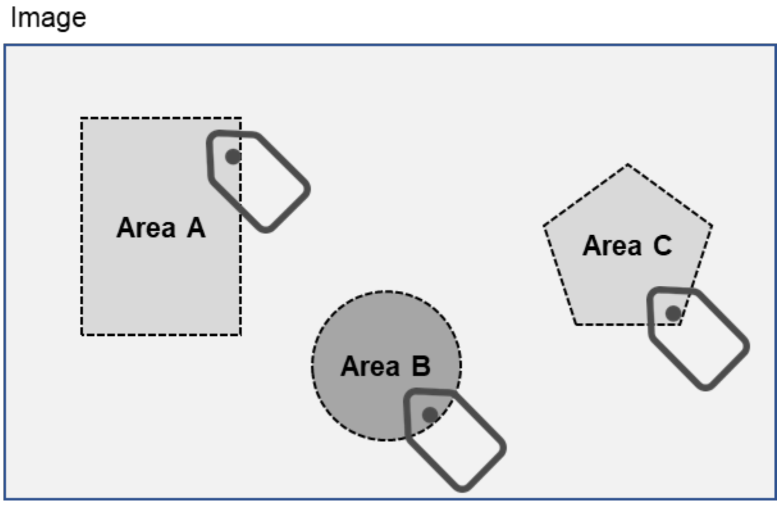


Figure 76 Specifying Multiple Independent Areas within Image

An area overlapping one area can be specified, and attached information can be written for each area.

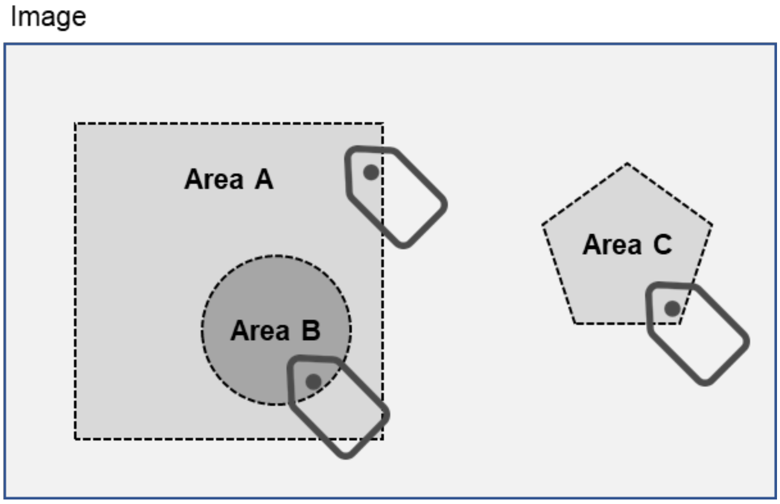


Figure 77 Overlapping Areas - 1: Specifying Area B in Area A

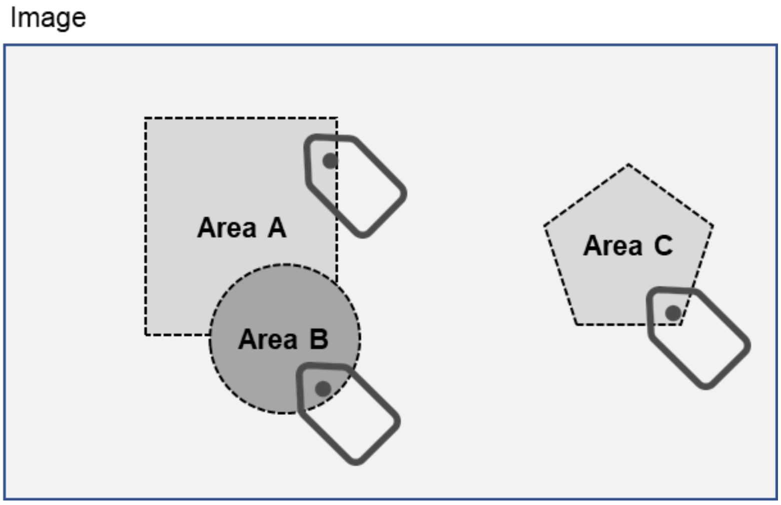


Figure 78 Overlapping Areas - 2: Specifying Area B Extending Across Area A

6.2.3.5. Defining a Layer Structure

Layer information is nested information corresponding to the subsequent set of annotation descriptions, and is intended to facilitate data classification and retrieval. Layer information can also be used to separate hierarchies.

The structure defines a "layer" as an object (single entity) within which annotation data can be written by nesting.

Table 38 Layer Structure

Language	Tag Name	Metadata	Nested Data
XML	exifEX:layer	String or numbers	Annotation data
JSON(JSON-LD)	exifEX:layer		

The layer information shall consist of one or more annotation data.

Multiple sets of layer information can be written for one image independently of each other.

Examples are shown below.

```
Layer A information:
          {Annotation information A-1, ⋯ , Annotation information A-n}

Layer B information:
          {Annotation information B-2, ⋯ , Annotation information B-m}

…
```

As necessary, an area can also be specified in the layer information.

7. Logo Mark Guidelines

Software and other products conforming to the JEITA Exif Standard Version 2.2 can use the logo mark shown below. See the JEITA Web page below for details.

http://www.jeita.or.jp/

Exif Print

8. References

The standards listed below comprise a part of this standard through their appearance as quotations or references. If a quoted or referenced standard provides the publish date (or, in the case of JIS, the year that the standard came into effect), only that version composes a part of this standard; any later revised versions, amendments, or supplements are not used. If the publish date (or year of coming into effect) is not added, the latest version (including amendments and supplements) is used.

[1] ExifR98	ExifR98 Version 1.0 **JEIDA-49-1** June,1998
[2] DCF	Design rule for Camera File system: **CIPA DC-009** http://www.cipa.jp/index.html **CP-3461** http://www.jeita.or.jp/
[3] MPF	Multi-Picture Format: **CIPA DC-007** http://www.cipa.jp/index.html
[4] ISO-2022-JP	Japanese Character Encoding for Internet Messages IETF (Internet Engineering Task Force) **RFC 1468 (ISO-2022-JP)** https://www.ietf.org/ 7-bit and 8-bit double byte coded KANJI sets for information interchange **JIS X 0208:1997 Annex 2** http://www.jsa.or.jp/
[5] JIS KANJI	7-bit and 8-bit double byte coded KANJI sets for information interchange **JIS X 0208** http://www.jsa.or.jp/
[6] ASTM E1708	Standard Practice for Electronic Interchange of Color and Appearance Data **ASTM E1708 - 95** http://www.astm.org/

[7] JPEG	Information technology — Digital compression and coding of continuous-tone still images: Requirements and guidelines **ISO/IEC 10918-1** http://www.iso.org/ **Recommendation T.81** http://www.itu.int/
[8] JPEG2000	Information technology — JPEG 2000 image coding system — Part 1: Core coding system **ISO/IEC 15444-1:2019** http://www.iso.org/
[9] JPEG-XT	Information technology — Scalable compression and coding of continuous-tone still images — Part 3: Box file format **ISO/IEC 18477-3:2015** http://www.iso.org/
[10] JUMBF	Information technologies — JPEG systems — Part 5: JPEG universal metadata box format(JUMBF) **ISO/IEC 19566-5:2019** http://www.iso.org/
[11] ISO 12232	Photography — Digital still cameras — Determination of exposure index, ISO speed ratings, standard output sensitivity, and recommended exposure index **ISO 12232** http://www.iso.org/
[12] Spatial Frequency Response	Photography — Electronic still-picture cameras — Resolution measurements **ISO 12233** http://www.iso.org/
[13] OECF	Photography — Electronic still-picture cameras — Methods for measuring opto-electronic conversion functions (OECFs) **ISO 14524** http://www.iso.org/

[14] sRGB	Multimedia systems and equipment — Colour measurement and management — Part 2-1: Colour management — Default RGB colour space — sRGB **IEC 61966-2-1 :1999** http://www.iec.ch/ Multimedia systems and equipment — Colour measurement and management — Part 2-1: Colour management — Default RGB colour space — sRGB — Amendment 1 IEC 61966-2-1:1999 / AMD1 :2003 http://www.iec.ch/
[15] PCM	Pulse code modulation(PCM) of voice frequencies **Recommendation G.711** http://www.itu.int/
[16] ASCII	American National Standard for Information Systems — Coded Character Sets — 7-Bit Standard Code for Information Interchange (7-Bit ASCII) American National Standards Institute **ANSI INCITS 4-1986** https://www.ansi.org/ International Reference Alphabet (IRA) (Formerly International Alphabet No. 5 or IA5) — Information technology — 7-bit coded character set for information interchange **Recommendation T.50** (09/1992) http://www.itu.int/
[17] TIFF	**TIFF Revision 6.0 Final**,June 3,1992 http://www.adobe.com/
[18] Flashpix	**Flashpix Format Specification Version 1.0**,September 11,1996 Eastman Kodak Company
[19] RIFF	**New Multimedia Data Types and Data Techniques**,1996 Microsoft Corporation http://www.microsoft.com/

[20] Unicode	**Unicode Standard**,1991 The Unicode Consortium http://www.unicode.org/
[21] UCS	Information technology — Universal coded character set (UCS) **ISO/IEC 10646** http://www.iso.org/
[22] XML	**Extensible Markup Language(XML)** https://www.w3.org/
[23] JSON	Information technology — The JSON data interchange syntax **ISO/IEC 21778** http://www.iso.org/
[24] JSON-LD	Graphic technology — Extensible metadata platform (XMP) specification — Part 3: JSON-LD serialization of XMP **ISO/IEC 16684-3** http://www.iso.org/
[25] IMA-ADPCM	**IMA Digital Audio Doc-Pac**,1992 The Interactive Multimedia Association(IMA)
[26] Directives2	ISO/IEC Directives, Part 2 “Rules for the structure and drafting of International Standards” http://www.iso.org/ http://www.jsa.or.jp/itn/pdf/shiryo/directives02.pdf

Annex

The meanings of the annex types stated in the annex titles are as follows:

[Normative]	: The annex provides an additional specification to the body of this standard.
[Informative]	: The annex is reference information for the understanding or use of this standard, and is outside the scope of specifications of this standard.

Annex A. [Informative]
Image File Description Examples

A.1 Uncompressed RGB File

Table 39 Uncompressed RGB File Description Sample Contents

Primary Image	
Pixels	640 (W) x 480 (H)
Image Title	Exif_TIFF_RGB
Image Input Equipment Manufacturer	DSCompany
Image Input Equipment Model Name	Example
Orientation	Normal
Strips	96
Lines per Strip	5
Bytes per Strip	9600
Image Resolution	72 dpi (Width), 72 dpi (Length)
Image Data Arrangement	Chunky
File Change Date and Time	2023:09:01 12:00:00.000
Copyright	Copyright,ABCDE,1997
Exif-specific Information	
Version	Version. 3.0
Date and Time of Original Image Creation	2023:09:01 12:00:00.000
Date and Time of File Creation	2023:09:01 12:00:00.000
Thumbnail	
Pixels	80 (W) x 60 (H)
Orientation	Normal
Strips	1
Lines per Strip	60
Bytes per Strip	14400
Image Resolution	72 dpi (Width), 72 dpi (Length)

Table 40 Uncompressed RGB File Description Sample

	Offset (Hex)	Name	Data (Hex or "ASCII")			
Header	0000	Byte Order	4D4D ("MM")			
	0002	42	002A			
	0004	0th IFD Offset	00000008			
0th IFD	**Offset (Hex)**	**Name**	**Entry Number (Hex)**			
	0008	Number of Entries	0014			
	Offset (Hex)	**Name**	**Tag ID (Hex)**	**Type (Hex)**	**Count (Hex)**	**ValueOffset (Hex or "ASCII")**
	000A	ImageWidth	0100	0004	00000001	00000280
	0016	ImageLength	0101	0004	00000001	000001E0
	0022	BitsPerSample	0102	0003	00000003	000000FE
	002E	Compression	0103	0003	00000001	00010000
	003A	PhotometricInterpretation	0106	0003	00000001	00020000
	0046	ImageDescription	010E	0002	0000000E	00000104
	0052	Make	010F	0002	00000009	00000112
	005E	Model	0110	0002	00000008	0000011C
	006A	StripOffsets	0111	0004	00000060	00000124
	0076	Orientation	0112	0003	00000001	00010000
	0082	SamplesPerPixel	0115	0003	00000001	00030000
	008E	RowsPerStrip	0116	0004	00000001	00000005
	009A	StripByteCounts	0117	0004	00000060	000002A4
	00A6	XResolution	011A	0005	00000001	00000424
	00B2	YResolution	011B	0005	00000001	0000042C
	00BE	PlanarConfiguration	011C	0003	00000001	00010000
	00CA	ResolutionUnit	0128	0003	00000001	00020000
	00D6	DateTime	0132	0002	00000014	00000434
	00E2	Copyright	8298	0002	00000015	00000484
	00EE	Exif IFD Pointer	8769	0004	00000001	0000045E
	Offset (Hex)	**Name**	**Offset (Hex)**			
	00FA	Next IFD Offset	000004EC			
Value longer than 4Byte of	**Offset (Hex)**	**Name**	**Data (Hex or "ASCII")**			
	00FE	BitPerSample Value	000800080008			

0th IFD	0104	ImageDescription Value	"Exif_TIFF_RGB"00			
	0112	Make Value	"DSCompany"00			
	011C	Model Value	"Example"00			
	0124	StripOffsets Value	offset0, offset1,offset2.....offset95			
	02A4	StripByteCounts Value	count0, count1, count2....count95			
	0424	XResolution Value	0000004800000001			
	042C	YResolution Value	0000004800000001			
	0434	DateTime Value	"2023:09:01 12:00:00"00			
	0448	Copyright Value (Last Byte is Padded)	"Copyright,ABCDE,1997"0000			
Exif IFD	**Offset (Hex)**	**Name**	**Entry Number (Hex)**			
	045E	Exif IFD Number	0008			
	Offset (Hex)	**Name**	**Tag ID (Hex)**	**Type (Hex)**	**Count (Hex)**	**ValueOffset (Hex or "ASCII")**
	0460	ExifVersion	9000	0007	00000004	"0300"
	046C	DateTimeOriginal	9003	0002	00000014	000004C4
	0478	DateTimeDigitized	9004	0002	00000014	000004D8
	0484	SubSecTime	9290	0002	00000004	"000"00
	0490	SubSecTimeOriginal	9291	0002	00000004	"000"00
	049C	SubSecTimeDigitized	9292	0002	00000004	"000"00
	04A8	FlashpixVersion	A000	0007	00000004	"0100"
	04B4	Colorspace	A001	0003	00000001	0001
	Offset (Hex)	**Name**	**Offset (Hex)**			
	04C0	Next IFD Offset	00000000			
Value longer than 4Byte of Exif IFD	**Offset (Hex)**	**Name**	**Data (Hex or "ASCII")**			
	04C4	SubSecTimeOriginal Value	"2023:09:01 12:00:00"00			
	04D8	SubSecTimeDigitized Value	"2023:09:01 12:00:00"00			
1st IFD	**Offset (Hex)**	**Name**	**Entry Number (Hex)**			
	04EC	Number Of Entries	000D			
	Offset (Hex)	**Name**	**Tag ID (Hex)**	**Type (Hex)**	**Count (Hex)**	**ValueOffset (Hex)**
	04EE	ImageWidth	0100	0004	00000001	00000050
	04FA	ImageLength	0101	0004	00000001	0000003C
	0506	BitsPerSample	0102	0003	00000003	0000058E

	0512	Compression	0103	0003	00000001	00010000
	051E	PhotometricInterpretation	0106	0003	00000001	00020000
	052A	StripOffsets	0111	0004	00000001	000005A4
	0536	SamplesPerPixel	0115	0003	00000001	00030000
	0542	RowsPerStrip	0116	0004	00000001	0000003C
	054E	StripByteCounts	0117	0004	00000001	00003840
	055A	XResolution	011A	0005	00000001	00000594
	0566	YResolution	011B	0005	00000001	0000059C
	0572	PlanarConfiguration	011C	0003	00000001	00010000
	057E	ResolutionUnit	0128	0003	00000001	00020000
	Offset (Hex)	**Name**	**Offset (Hex)**			
	058A	Next IFD Offset	00000000			
Value longer than 4Byte of 1st IFD	**Offset (Hex)**	**Name**	**Data (Hex or "ASCII")**			
	058E	BitPerSample Value	000800080008			
	0594	XResolution Value	0000004800000001			
	059C	YResolution Value	0000004800000001			
	05A4	Thumbnail Image Data Strip	:			
Primary Image Data	**Offset (Hex)**	**Name**	**Data (Hex or "ASCII")**			
	3DE4	Primary Image Data Strip0	:			
	6364	Primary Image Data Strip1	:			
	:	:	:			
	:	:	:			
	0E2864	Primary Image Data Strip95	:			

A.2 Uncompressed YCbCr File

Table 41 Uncompressed YCbCr File Description Sample Contents

Primary Image	
Pixels	640 (W) x 480 (H)
Image Title	Exif_TIFF_YCC
Image Input Equipment Manufacturer	DSCompany
Image Input Equipment Model Name	Example
Orientation	Normal

Strips	69
Lines per Strip	7
Bytes per Strip	8960
Image Resolution	72 dpi (Width), 72 dpi (Length)
Image Data Arrangement	Chunky
File Change Date and Time	2023:09:01 12:00:00
Pixel Composition	Subsampling = 4:2:2 Chrominance Subsampling point matches luminance point
Copyright	Copyright,ABCDE,1997
Exif-specific Information	
Version	Version. 3.0
Date and Time of Original Image Creation	2023:09:01 12:00:00
Date and Time of File Creation	2023:09:01 12:00:00
Shutter Speed	59/10 (equivalent to 1/60 sec.)
Aperture	50/10 (equivalent to F:5.6)
Brightness	80/10
Exposure Bias	0/0
Maximum Lens Aperture	200/10
Subject Distance	20/10
Metering Mode	MultiSpot
Light Source	Daylight
Flash ON/OFF	ON
GPS Information	
Version	Version. 2.3
Measurement Position	North Latitude 35 deg. 48 min. 8 sec., East Longitude 139 deg. 34 min. 55 sec.
Altitude	30.48 meters above sea level
GPS Time	0:00:00
GPS Receiver Movement	Moving at 1km/h at 0 deg. true direction

Image Direction	0 deg. true direction
Geodetic Data Used for Measurement	TOKYO
Thumbnail	
Pixels	80 (W) x 60 (H)
Orientation	Normal
Strips	1
Lines per Strip	60
Bytes per Strip	9600
Image Resolution	72 dpi (Width), 72 dpi (Length)

Table 42 Uncompressed YCbCr File Description Sample

	Offset (Hex)	**Name**	**Data (Hex or "ASCII")**			
Header	0000	Byte Order	4949 ("II")			
	0002	42	2A00			
	0004	0th IFD Offset	08000000			
0th IFD	**Offset (Hex)**	**Name**	**Entry Number (Hex)**			
	0008	Number of Entries	1700			
	Offset (Hex)	**Name**	**Tag ID (Hex)**	**Type (Hex)**	**Count (Hex)**	**ValueOffset (Hex or "ASCII")**
	000A	ImageWidth	0001	0400	01000000	80020000
	0016	ImageLength	0101	0400	01000000	E0010000
	0022	BitsPerSample	0201	0300	03000000	22010000
	002E	Compression	0301	0300	01000000	01000000
	003A	PhotometricInterpretation	0601	0300	01000000	06000000
	0046	ImageDescription	0E01	0200	0E000000	28010000
	0052	Make	0F01	0200	09000000	36010000
	005E	Model	1001	0200	08000000	40010000
	006A	StripOffsets	1101	0400	45000000	48010000
	0076	Orientation	1201	0300	01000000	01000000
	0082	SamplesPerPixel	1501	0300	01000000	03000000
	008E	RowsPerStrip	1601	0400	01000000	07000000
	009A	StripByteCounts	1701	0400	45000000	5C020000
	00A6	XResolution	1A01	0500	01000000	70030000

	00B2	YResolution	1B01	0500	01000000	78030000
	00BE	PlanarConfiguration	1C01	0300	01000000	01000000
	00CA	ResolutionUnit	2801	0300	01000000	02000000
	00D6	DateTime	3201	0200	14000000	80030000
	00E2	YCbCrSubSampling	1202	0300	02000000	02000100
	00EE	YCbCrPositioning	1302	0300	01000000	02000000
	00FA	Copyright	9882	0200	15000000	94030000
	0106	Exif IFD Pointer	6987	0400	01000000	AA030000
	0112	GPS IFD Offset	2588	0400	01000000	10050000
	Offset (Hex)	**Name**	**Offset (Hex)**			
	011E	Next IFD Offset	7E060000			
Value longer than 4Byte of 0th IFD	**Offset (Hex)**	**Name**	**Data (Hex or "ASCII")**			
	0122	BitPerSample Value	080008000800			
	0128	ImageDescription Value	"Exif_TIFF_YCC"00			
	0136	Make Value	"DSCompany"00			
	0140	Model Value	"Example"00			
	0148	StripOffsets Value	(offset0, offset1,offset2.....offset95)			
	025C	StripByteCounts Value	(count0, count1, count2....count95)			
	0370	XResolution Value	4800000001000000			
	037C	YResolution Value	4800000001000000			
	0380	DateTime Value	"2023:09:01 12:00:00"00			
	0394	Copyright Value (Last Byte is Padded)	"Copyright,ABCDE,1997"0000			
Exif IFD	**Offset (Hex)**	**Name**	**Entry Number (Hex)**			
	03AA	Exif IFD Number	1400			
	Offset (Hex)	**Name**	**Tag ID (Hex)**	**Type (Hex)**	**Count (Hex)**	**ValueOffset (Hex or "ASCII")**
	03AC	ExposureTime	9A82	0500	01000000	A0040000
	03B8	FNumber	9D82	0500	01000000	A8040000
	03C4	ExifVersion	0090	0700	04000000	"0300"
	03D0	DateTimeOriginal	0390	0200	14000000	B0040000
	03DC	DateTimeDigitized	0490	0200	14000000	C4040000
	03E8	ShutterSpeedValue	0192	0A00	01000000	D8040000
	03F4	ApertureValue	0292	0500	01000000	E0040000
	0400	BrightnessValue	0392	0A00	01000000	E8040000

	040C	ExposureBiasValue	0492	0A00	01000000	F0040000
	0418	MaxApertureRatioValue	0592	0500	01000000	F8040000
	0424	SubjectDistance	0692	0500	01000000	00050000
	0430	MeteringMode	0792	0300	01000000	01000000
	043C	LightSource	0892	0300	01000000	01000000
	0448	Flash	0992	0300	01000000	01000000
	0454	FocalLength	0A92	0500	01000000	08050000
	0460	SubSecTime	9092	0200	04000000	"000"00
	046C	SubSecTimeOriginal	9192	0200	04000000	"000"00
	0478	SubSecTimeDigitized	9292	0200	04000000	"000"00
	0484	FlashpixVersion	00A0	0700	04000000	"0100"
	0490	ColorSpace	01A0	0300	01000000	01000000
	Offset (Hex)	**Name**	**Offset (Hex)**			
	049C	Next IFD Offset	00000000			
Value longer than 4Byte ofExif IFD	**Offset (Hex)**	**Name**	**Data (Hex or "ASCII")**			
	04A0	ExposureTime Value	010000003C000000			
	04A8	FNumber Value	0400000001000000			
	04B0	DateTimeOriginal Value	"2023:09:01 12:00:00"00			
	04C4	DateTimeDigitized Value	"2023:09:01 12:00:00"00			
	04D8	ShutterSpeed Value	0600000001000000			
	04E0	ApertureValue Value	0400000001000000			
	04E8	BrightnessValue Value	0000000001000000			
	04F0	ExposureBiasValue Value	0000000001000000			
	04F8	MaxApertureRatio Value	0100000001000000			
	0500	SubjectDistance Value	0F0000000A000000			
	0508	FocalLength Value	3200000001000000			
GPS IFD	**Offset (Hex)**	**Name**	**Entry Number (Hex)**			
	0510	GPS IFD Number	0013			
	Offset (Hex)	**Name**	**Tag ID (Hex)**	**Type (Hex)**	**Count (Hex)**	**ValueOffset (Hex or "ASCII")**
	0512	GPSVersionID	0000	0100	04000000	02030000
	051E	GPSLatitudeRef	0100	0200	02000000	"N"000000
	052A	GPSLatitude	0200	0500	03000000	FA050000
	0536	GPSLongitudeRef	0300	0200	02000000	"E"000000

	0542	GPSLongitude	0400	0500	03000000	12060000
	054E	GPSAltitudeRef	0500	0100	01000000	00000000
	055A	GPSAltitude	0600	0500	01000000	2A060000
	0566	GPSTimeStamp	0700	0500	03000000	32060000
	0572	GPSSatellites	0800	0200	0D000000	4A060000
	057E	GPSStatus	0900	0200	02000000	"A"000000
	058A	GPSMeasureMode	0A00	0200	02000000	"2"000000
	0596	GPSDOP	0B00	0500	01000000	58060000
	05A2	GPSSpeedRef	0C00	0200	02000000	"K"000000
	05AE	GPSSpeed	0D00	0500	01000000	60060000
	05BA	GPSTrackRef	0E00	0200	02000000	"T"000000
	05C6	GPSTrack	0F00	0500	01000000	68060000
	05D2	GPSImgDirectionRef	1000	0200	02000000	"T"000000
	05DE	GPSImgDirection	1100	0500	01000000	70060000
	05EA	GPSMapDatum	1200	0200	06000000	78060000
	Offset (Hex)	**Name**	**Offset (Hex)**			
	05F6	Next IFD Offset	00000000			
Value longer than 4Byte of GPS IFD	**Offset (Hex)**	**Name**	**Data (Hex or "ASCII")**			
	05FA	GPSLatitude Value	2300000001000000 3000000001000000 0800000001000000			
	0612	GPSLongitude Value	8B00000001000000 2200000001000000 3700000001000000			
	062A	GPSAltitude Value	E80B000064000000			
	0632	GPSTimeStamp Value	0000000001000000 0000000001000000 0000000001000000			
	064A	GPSSatellites Value (Last Byte is padded)	"2,7,14,15,16"0000			
	0658	GPSDOP Value	0100000001000000			
	0660	GPSSpeed Value	0000000001000000			
	0668	GPSTrack Value	0000000001000000			
	0670	GPSImgDirection Value	0000000001000000			
	0678	GPSMapDatum Value	"TOKYO"00			

	Offset (Hex)	Name	Entry Number (Hex)			
1st IFD	067E	Number Of Entries	0F00			
	Offset (Hex)	**Name**	**Tag ID (Hex)**	**Type (Hex)**	**Count (Hex)**	**ValueOffset (Hex or "ASCII")**
	0680	ImageWidth	0001	0400	01000000	50000000
	068C	ImageLength	0101	0400	01000000	3C000000
	0698	BitsPerSample	0201	0300	03000000	38070000
	06A4	Compression	0301	0300	01000000	01000000
	06B0	PhotometricInterpretation	0601	0300	01000000	06000000
	06BC	StripOffsets	1101	0400	01000000	4E070000
	06C8	SamplesPerPixel	1501	0300	01000000	03000000
	06D4	RowsPerStrip	1601	0400	01000000	3C000000
	06E0	StripByteCounts	1701	0400	01000000	80250000
	06EC	XResolution	1A01	0500	01000000	3E070000
	06F8	YResolution	1B01	0500	01000000	46070000
	0704	PlanarConfiguration	1C01	0300	01000000	01000000
	0710	ResolutionUnit	2801	0300	01000000	02000000
	071C	YCbCrSubSampling	1202	0300	02000000	02000100
	0728	YCbCrPositioning	1302	0300	01000000	02000000
	Offset (Hex)	**Name**	**Offset (Hex)**			
	0734	Next IFD Offset	00000000			
	Offset (Hex)	**Name**	**Data (Hex or "ASCII")**			
Value longer than 4Byte of 1st IFD	0738	BitPerSample Value	080008000800			
	073E	XResolution Value	4800000001000000			
	0746	YResolution Value	4800000001000000			
	074E	(Thumbnail Image Data Strip)				
	Offset (Hex)	**Name**	**Data (Hex or "ASCII")**			
Primary Image Data	2CCE	Image Data Strip0	:			
	4FCE	Image Data Strip1	:			
	:	:	:			
	:	:	:			
	0978CE	Image Data Strip68	:			

A.3 JPEG Compressed (4:2:2) File

Table 43 JPEG Compressed (4:2:2) File Description Sample Contents

Primary Image	
Recording Format	JPEG
Subsampling	YCC 4:2:2
Restart Markers	Inserted
Quantization Tables	3
Pixels	640 (W) x 480 (H)
Image Title	Exif_JPEG_422
Image Input Equipment Manufacturer	DS Company
Image Input Equipment Model Name	Example
Orientation	Normal
Image Resolution	72 dpi (Width), 72 dpi (Length)
File Change Date and Time	2023:09:01 12:00:00
Copyright	Copyright,ABCDE,1997
Exif-specific Information	
Version	Version. 3.0
Date and Time of Original Image Creation	2023:09:01 12:00:00
Date and Time of File Creation	2023:09:01 12:00:00
Components	Y,Cb,Cr
Image Compression Mode	2bit/pel
Shutter Speed	59/10 (equivalent to 1/60 sec.)
Aperture	50/10 (equivalent to F:5.6)
Brightness	80/10
Exposure Bias	0/0
Maximum Lens Aperture	200/10
Subject Distance	20/10
Metering Mode	MultiSpot
Light Source	Daylight
Flash ON/OFF	ON
Thumbnails	
Recording Format	JPEG
Subsampling	YCC 4:2:2
Pixels	80 (W) x 60 (H)
Image Resolution	72 dpi (Width), 72 dpi (Length)

Table 44 JPEG Compressed (4:2:2) File JPEG Stream Description Sample

Offset (Hex)	Marker Segment	Name	Code (Hex)	Comment
0000	SOI	SOI Marker	FFD8	Start of Image
0002	APP1	APP1 Marker	FFE1	
0004		APP1 Length	291C	
0006		Identifier	"Exif"00	
000B		Pad	00	
000C		APP1 Body		See Next Table
0E39	DQT	DQT Marker	FFDB	Define Quantization Table
0E3B		DQT Length	00C5	
0E3D		Pq, Tq	00	
0E3E		table elements	100B0C0E.....	64 Bytes of Data
0E7E		Pq,Tq	01	
0E7F		table elements	0F101016....	64 Bytes of Data
0EBF		Pq,Tq	02	
0EC0		table elements	0F101016....	64 Bytes of Data
0F00	DHT	DHT Marker	FFC4	
0F02		DHT Length	01A2	
0F04		Th	00	Table 0 for DC
0F05		Li	00010501....	
0F15		Vij	00010203....	
0F21		Th	10	Table 0 for AC
0F22		Li	00020103....	
0F32		Vij	01020300....	
0FD4		Th	01	Table 1 for DC
0FD5		Li	00030101....	
0FE5		Vij	00010203....	
0FF1		Th	11	Table 1 for AC
0FF2		Li	00020102....	
1002		Vij	00010203....	
10A4	DRI	DRI Marker	FFDD	
10A6		DRI Length	0004	
10A8		Ri	0004	
10AA	SOF0	SOF0 Marker	FFC0	
10AC		SOF0 Length	0011	

10AE		P	08	
10AF		Y	01E0	
10B1		X	0280	
10B3		Nf	03	
10B4		C1	01	
10B5		H1,V1	21	
10B6		Tq1	00	
10B7		C2	02	
10B8		H2,V2	11	
10B9		Tq2	01	
10BA		C3	03	
10BB		H3,V3	11	
10BC		Tq3	02	
10BD	SOS	SOS Marker	FFDA	
10BF		SOS Length	000C	
10C1		Ns	03	
10C2		Cs1	01	
10C3		Td1,Ta1	00	
10C4		Cs2	02	
10C5		Td2,Ta2	11	
10C6		Cs3	03	
10C7		Td3,Ta3	11	
10C8		Ss	00	
10C9		Se	3F	
10CA		Ah,Al	00	
10CB	Image Data		F36A....	Compressed Data
111C4	EOI		FFD9	

Table 45 JPEG Compressed (4:2:2) File APP1 Description Sample

	Offset (Hex)	Name	Data (Hex or "ASCII")
Header	0000	Byte Order	4949 ("II")
	0002	42	2A00
	0004	0th IFD Offset	08000000

	Offset (Hex)	**Name**	**Entry Number (Hex)**			
0th IFD	0008	Number of Entries	0B00			
	Offset (Hex)	**Name**	**Tag ID (Hex)**	**Type (Hex)**	**Count (Hex)**	**ValueOffset (Hex or "ASCII")**
	000A	ImageDescription	0E01	0200	0E000000	92000000
	0016	Make	0F01	0200	09000000	A0000000
	0022	Model	1001	0200	08000000	AA000000
	002E	Orientation	1201	0300	01000000	01000000
	003A	XResolution	1A01	0500	01000000	B2000000
	0046	YResolution	1B01	0500	01000000	BA000000
	0052	ResolutionUnit	2801	0300	01000000	02000000
	005E	DateTime	3201	0200	14000000	C2000000
	006A	YCbCrPositioning	1302	0300	01000000	02000000
	0076	CopyRight	9882	0200	15000000	D6000000
	0082	Exif IFD Pointer	6987	0400	01000000	EC000000
	Offset (Hex)	**Name**	**Offset (Hex)**			
	008E	Next IFD Offset	C402			
Value longer than 4Byte of 0th IFD	**Offset (Hex)**	**Name**	**Data (Hex or "ASCII")**			
	0092	ImageDescription Value	"Exif_JPEG_422"00			
	00A0	Make Value	"DSCompany"00			
	00AA	Model Value	"Example"00			
	00B2	XResolution Value	4800000001000000			
	00BA	YResolution Value	4800000001000000			
	00C2	DateTime Value	"2023:09:01 12:00:00"00			
	00D6	Copyright Value (Last Byte is Padded)	"Copyright,ABCDE,1997"0000			
Exif IFD	**Offset (Hex)**	**Name**	**Entry Number (Hex)**			
	00EC	Exif IFD Number	1900			
	Offset (Hex)	**Name**	**Tag ID (Hex)**	**Type (Hex)**	**Count (Hex)**	**ValueOffset (Hex or "ASCII")**
	00EE	ExposureTime	9A82	0500	01000000	1E020000
	00FA	FNumber	9D82	0500	01000000	26020000
	0106	ExifVersion	0090	0700	04000000	"0300"

	0112	DateTimeOriginal	0390	0200	14000000	2E020000
	011E	DateTimeDigitized	0490	0200	14000000	42020000
	012A	ComponentsConfiguration	0191	0700	04000000	01020000
	0136	CompressedBitsPerPixel	0292	0500	01000000	56020000
	0142	ShutterSpeedValue	0192	0A00	01000000	5E020000
	014E	ApertureValue	0292	0500	01000000	66020000
	015A	BrightnessValue	0392	0A00	01000000	6E020000
	0166	ExposureBiasValue	0492	0A00	01000000	76020000
	0172	MaxApertureRatioValue	0592	0500	01000000	7E020000
	017E	SubjectDistance	0692	0500	01000000	86020000
	018A	MeteringMode	0792	0300	01000000	01000000
	0196	LightSource	0892	0300	01000000	01000000
	01A2	Flash	0992	0300	01000000	00000000
	01AE	FocalLength	0A92	0500	01000000	8E020000
	01BA	UserComments	8692	0700	2E000000	96020000
	01C6	SubSecTime	9092	0200	04000000	"000"00
	01D2	SubSecTimeOriginal	9192	0200	04000000	"000"00
	01DE	SubSecTimeDigitized	9292	0200	04000000	"000"00
	01EA	FlashpixVersion	00A0	0700	04000000	"0100"
	01F6	Colorspace	01A0	0300	01000000	01000000
	0202	Pixel X Dimension	02A0	0400	01000000	80020000
	020E	Pixel Y Dimension	03A0	0400	01000000	E0010000
	Offset (Hex)	**Name**	**Offset (Hex)**			
	021A	Next IFD Offset	00000000			
Value longer than 4Byte of Exif IFD	**Offset (Hex)**	**Name**	**Data (Hex or "ASCII")**			
	021E	ExposureTime Value	010000003C000000			
	0226	FNumber Value	0400000001000000			
	022E	DateTimeOriginal Value	"2023:09:01 12:00:00"00			
	0242	DateTimeDigitized Value	"2023:09:01 12:00:00"00			
	0256	CompressedBitsPerPixel Value	0200000001000000			
	025E	ShutterSpeedValue Value	0600000001000000			
	0266	ApertureValue Value	0400000001000000			
	026E	BrightnessValue Value	0000000001000000			
	0276	ExposureBiasValue Value	0000000001000000			
	027E	MaxApertureRatioValue Value	0100000001000000			

	0286	SubjectDistance Value	0F0000000A000000			
	028E	FocalLength Value	3200000001000000			
	0296	UserComment Value (46 Bytes)	4A49530000000000....			
1st IFD	**Offset (Hex)**	**Name**	**Entry Number (Hex)**			
	02C4	Number Of Entries	0700			
	Offset (Hex)	**Name**	**Tag ID (Hex)**	**Type (Hex)**	**Count (Hex)**	**ValueOffset (Hex or "ASCII")**
	02C6	Compression	0301	0300	01000000	01000000
	02D2	XResolution	1A01	0500	01000000	1E030000
	02DE	YResolution	1B01	0500	01000000	26030000
	02EA	ResolutionUnit	2801	0300	01000000	02000000
	02F6	JPEGInterchangeFormat	0102	0400	01000000	2D0E0000
	0302	JPEGInterchangeFormatLength	0202	0400	01000000	FF0A0000
	030E	YCbCrPositioning	1302	0300	01000000	02000000
	Offset (Hex)	**Name**	**Offset (Hex)**			
	031A	Next IFD Offset	00000000			
Value longer than 4Byte of 1st IFD	**Offset (Hex)**	**Name**	**Data (Hex or "ASCII")**			
	031E	XResolution Value	4800000001000000			
	0326	YResolution Value	4800000001000000YResolution Value			
Thumbnail Image Data	**Offset (Hex)**	**Name**	**Data**			
	032E	Thumbnail Data	(JPEG Stream)			

A.4 JPEG Compressed (4:2:0) File

Table 46 JPEG Compressed (4:2:0) File Description Sample Contents

Primary Image	
Recording Format	JPEG
Subsampling	YCC 4:2:0
Restart Markers	Inserted
Quantization Tables	2
Pixels	620 (W) x 475 (H)
Image Title	620x475

SOF Recorded Pixels	640x475
DCT Data	640x480
Image Title	Exif_JPEG_420
Image Input Equipment Manufacturer	DSCompany
Image Input Equipment Model Name	Example
Orientation	Normal
Image Resolution	72 dpi (Width), 72 dpi (Length)
File Change Date and Time	2023:09:01 12:00:00
Copyright	Copyright,ABCDE,1997
Exif-specific Information	
Version	Version. 3.0
Date and Time of Original Image Creation	2023:09:01 12:00:00
Date and Time of File Creation	2023:09:01 12:00:00
Components	Y,Cb,Cr
Image Compression Mode	2bit/pel
Shutter Speed	59/10 (equivalent to 1/60 sec.)
Aperture	50/10 (equivalent to F:5.6)
Brightness	80/10
Exposure Bias	0/0
Maximum Lens Aperture	200/10
Subject Distance	20/10
Metering Mode	MultiSpot
Light Source	Daylight
Flash ON/OFF	ON
Thumbnails	
Recording Format	TIFF
Subsampling	YCC 4:2:0
Pixels	80x60
Image Resolution	72 dpi (Width), 72 dpi (Length)

Table 47 JPEG Compressed (4:2:0) File JPEG Stream Description Sample

Offset (Hex)	Marker Segment	Name	Code (Hex)	Comment
0000	SOI	SOI Marker	FFD8	Start of Image
0002	APP1	APP1 Marker	FFE1	
0004		APP1 Length	1FBC	
0006		Identifier	"Exif"00	

000B		Pad	00	
000C		APP1 Body		See Next Table
1FC0	DQT	DQT Marker	FFDB	Define Quantization Table
1FC2		DQT Length	0084	
1FC4		Pq, Tq	00	
1FC5		table elements	08060607....	64 Bytes of Data
2005		Pq,Tq	01	
2006		table elements	0909090C....	64 Bytes of Data
2046	DHT	DHT Marker	FFC4	
2048		DHT Length	01A2	
204A		Th	00	Table 0 for DC
204B		Li	00010501....	
205B		Vij	00010203....	
2067		Th	10	Table 0 for AC
2068		Li	00020103....	
2078		Vij	01020300....	
211A		Th	01	Table 1 for DC
211B		Li	00030101....	
212B		Vij	00010203....	
2137		Th	11	Table 1 for AC
2138		Li	00020102....	
2148		Vij	00010203....	
21EA	DRI	DR Marker	FFDD	
21EC		DRI Length	0004	
21EE		Ri	0004	
21F0	SOF0	SOF0 Marker	FFC0	
21F2		SOF0 Length	0011	
21F4		P	08	
21F5		Y	01DB	
21F7		X	0280	
21F9		Nf	03	
21FA		C1	01	
21FB		H1,V1	22	
21FC		Tq1	00	
21FD		C2	02	

21FE		H2,V2	11	
21FF		Tq2	01	
2200		C3	03	
2201		H3,V3	11	
2202		Tq3	01	
2203	SOS	SOS Marker	FFDA	
2205		SOS Length	000C	
2207		Ns	03	
2208		Cs1	01	
2209		Td1,Ta1	00	
220A		Cs2	02	
220B		Td2,Ta2	11	
220C		Cs3	03	
220D		Td3,Ta3	11	
220E		Ss	00	
220F		Se	3F	
2210		Ah,Al	00	
2211	Image Data		F9FE....	Compressed Data
13BA4	EOI		FFD9	

Table 48 JPEG Compressed (4:2:0) File APP1 Description Sample

<table>
<tr><td rowspan="4">Header</td><th>Offset
(Hex)</th><th>Name</th><th colspan="4">Data
(Hex or "ASCII")</th></tr>
<tr><td>0000</td><td>Byte Order</td><td colspan="4">4949 ("II")</td></tr>
<tr><td>0002</td><td>42</td><td colspan="4">2A00</td></tr>
<tr><td>0004</td><td>0th IFD Offset</td><td colspan="4">08000000</td></tr>
<tr><td rowspan="8">0th IFD</td><th>Offset
(Hex)</th><th>Name</th><th colspan="4">Entry Number
(Hex)</th></tr>
<tr><td>0008</td><td>Number of Entries</td><td colspan="4">0B00</td></tr>
<tr><th>Offset
(Hex)</th><th>Name</th><th>Tag ID
(Hex)</th><th>Type
(Hex)</th><th>Count
(Hex)</th><th>ValueOffset
(Hex or "ASCII")</th></tr>
<tr><td>000A</td><td>ImageDescription</td><td>0E01</td><td>0200</td><td>0E000000</td><td>92000000</td></tr>
<tr><td>0016</td><td>Make</td><td>0F01</td><td>0200</td><td>09000000</td><td>A0000000</td></tr>
<tr><td>0022</td><td>Model</td><td>1001</td><td>0200</td><td>08000000</td><td>AA000000</td></tr>
<tr><td>002E</td><td>Orientation</td><td>1201</td><td>0300</td><td>01000000</td><td>01000000</td></tr>
<tr><td>003A</td><td>XResolution</td><td>1A01</td><td>0500</td><td>01000000</td><td>B2000000</td></tr>
</table>

	0046	YResolution	1B01	0500	01000000	BA000000
	0052	ResolutionUnit	2801	0300	01000000	02000000
	005E	DateTime	3201	0200	14000000	C2000000
	006A	YCbCrPositioning	1302	0300	01000000	02000000
	0076	Copyright	9882	0200	15000000	D6000000
	0082	Exif IFD Pointer	6987	0400	01000000	EC000000
	Offset (Hex)	**Name**	**Offset (Hex)**			
	008E	Next IFD Offset	C402			
Value longer than 4Byte of 0th IFD	**Offset (Hex)**	**Name**	**Data (Hex or "ASCII")**			
	0092	ImageDescription Value	"Exif_JPEG_420"00			
	00A0	Make Value	"DSCompany"00			
	00AA	Model Value	"Example"00			
	00B2	XResolution Value	4800000001000000			
	00BA	YResolution Value	4800000001000000			
	00C2	DateTime Value	"2023:09:01 12:00:00"00			
	00D6	Copyright Value (Last Byte is Padded)	"Copyright,ABCDE,1997"0000			
Exif IFD	**Offset (Hex)**	**Name**	**Entry Number (Hex)**			
	00EC	Exif IFD Number	1900			
	Offset (Hex)	**Name**	**Tag ID (Hex)**	**Type (Hex)**	**Count (Hex)**	**ValueOffset (Hex or "ASCII")**
	00EE	ExposureTime	9A82	0500	01000000	1E020000
	00FA	FNumber	9D82	0500	01000000	26020000
	0106	ExifVersion	0090	0700	04000000	"0300"
	0112	DateTimeOriginal	0390	0200	14000000	2E020000
	011E	DateTimeDigitized	0490	0200	14000000	42020000
	012A	ComponentsConfiguration	0191	0700	04000000	01020300
	0136	CompressedBitsPerPixel	0292	0500	01000000	56020000
	0142	ShutterSpeedValue	0192	0A00	01000000	5E020000
	014E	ApertureValue	0292	0500	01000000	66020000
	015A	BrightnessValue	0392	0A00	01000000	6E020000
	0166	ExposureBiasValue	0492	0A00	01000000	76020000
	0172	MaxApertureRatioValue	0592	0500	01000000	7E020000
	017E	SubjectDistance	0692	0500	01000000	86020000

	018A	MeteringMode	0792	0300	01000000	01000000
	0196	LightSource	0892	0300	01000000	01000000
	01A2	Flash	0992	0300	01000000	00000000
	01AE	FocalLength	0A92	0500	01000000	8E020000
	01BA	UserComments	8692	0700	2E000000	96020000
	01C6	SubSecTime	9092	0200	04000000	30303000
	01D2	SubSecTimeOriginal	9192	0200	04000000	"000"00
	01DE	SubSecTimeDigitized	9292	0200	04000000	"000"00
	01EA	FlashpixVersion	00A0	0700	04000000	"0100"
	01F6	ColorSpace	01A0	0300	01000000	01000000
	0202	Pixel X Dimension	02A0	0400	01000000	6C020000
	020E	Pixel Y Dimension	03A0	0400	01000000	DB010000
	Offset (Hex)	**Name**	**Offset (Hex)**			
	021A	Next IFD Offset	00000000			
Value longer than 4 Bytes of Exif IFD	**Offset (Hex)**	**Name**	**Data (Hex or "ASCII")**			
	021E	ExposureTime Value	010000003C000000			
	0226	FNumber Value	0400000001000000			
	022E	DateTimeOriginal Value	"2023:09:01 12:00:00"00			
	0242	DateTimeDigitized Value	"2023:09:01 12:00:00"00			
	0256	CompressedBitsPerPixel Value	0200000001000000			
	025E	ShutterSpeedValue Value	0600000001000000			
	0266	ApertureValue Value	0400000001000000			
	026E	BrightnessValue Value	0000000001000000			
	0276	ExposureBiasValue Value	0000000001000000			
	027E	MaxApertureRatioValue Value	0100000001000000			
	0286	SubjectDistance Value	0F0000000A000000			
	028E	FocalLength Value	3200000001000000			
	0296	UserComment Value (46 Bytes)	4A49530000000000....			
1st IFD	**Offset (Hex)**	**Name**	**Entry Number (Hex)**			
	02C4	Number Of Entries	0F00			
	Offset (Hex)	**Name**	**Tag ID (Hex)**	**Type (Hex)**	**Count (Hex)**	**ValueOffset (Hex or "ASCII")**
	02C6	ImageWidth	0001	0400	01000000	50000000

	02D2	ImageLength	0101	0400	01000000	3C000000
	02DE	BitsPerSample	0201	0300	03000000	7E030000
	02EA	Compression	0301	0300	01000000	01000000
	02F6	PhotometricInterpretation	0601	0300	01000000	06000000
	0302	StripOffsets	1101	0400	01000000	94030000
	030E	SamplesPerPixel	1501	0300	01000000	03000000
	031A	RowsPerStrip	1601	0400	01000000	3C000000
	0326	StripByteCounts	1701	0400	01000000	201C0000
	0332	XResolution	1A01	0500	01000000	84030000
	033E	YResolution	1B01	0500	01000000	8C030000
	034A	PlanarConfiguration	1C01	0300	01000000	01000000
	0356	ResolutionUnit	2801	0300	01000000	02000000
	0362	YCbCrSubSampling	1202	0300	02000000	02000200
	036E	YCbCrPositioning	1302	0300	01000000	02000000
	Offset (Hex)	**Name**	**Offset (Hex)**			
	037A	Next IFD Offset	00000000			
Value longer than 4Byte of 1st IFD	**Offset (Hex)**	**Name**	**Data (Hex or "ASCII")**			
	037E	BitsPerSample Value	080008000800			
	0384	XResolution Value	4800000001000000			
	038C	YResolution Value	4800000001000000			
Thumbnail Image Data	**Offset (Hex)**	**Name**	**Data (Hex or "ASCII")**			
	0394	Thumbnail Image Data Strip	:			

Annex B. [Informative]
Audio File Description Examples

B.1 PCM Audio Data

Table 49 PCM Audio File Description Sample Contents

Audio Data	
Format Type	PCM Format
Channels	monaural
Sampling Frequency	22.050KHz
Bits per Sample	8 Bits/Sample
Total Samples	27768 Samples
Attribute Information	
Audio Title	“ExifPCMExampleZ”
Audio Genre	None
Recording Date	“2023-07-13”Z
Recording Engineer	“Taro Yamada”Z
Copyright	“Copyright Exif Corporation on 1997.”Z
Exif-specific Information	
Exif Version	“0300” (Version 3.0)
Related Exif Image File	“DSC00001.JPG”Z
Recording Start Time	“10:15:30.130”Z
Recording Equipment Manufacturer	“DSC Corporation”Z
Recording Equipment Model	“DSC1000”Z
Manufacturer Note	None
User Comment	None

Text enclosed in " " is a character string, and ‘Z’ means a character string ending in NULL[00.H]

Table 50 PCM Audio File Description Example

	Offset (Hex)	Name	Comment	Data (Hex or “Ascii”)
RIFF-ck	0000	ckID	RIFF	52494646
	0004	ckSize		786D0000
	0008	formType	WAVE	57415645
fmt-ck	000C	ckID	fmt[20.H]	666D7420
	0010	ckSize		10000000

		0014	wFormatTag	PCM Format	0100
		0016	nchannels	monaural	0100
		0018	nSamplesPerSec	22.050KHz	22560000
		001C	nAvgBytesPerSec	22050 Bytes/sec	22560000
		0020	nBlockAlign	1 Byte/block	0100
		0022	wBitsPerSample	8 bits/sample	0800
INFO-LIST		0024	ckID	LIST	4C495354
		0028	ckSize		70000000
		002C	listType	INFO	494E464F
	INAM-ck	0030	ckID	INAM	494E414D
		0034	ckSize		0F000000
		0038	ckData	(audio title)	"ExifPCMExample"00
		0047	(pad)	Padding byte	00
	ICRD-ck	0048	ckID	ICRD	49435244
		004C	ckSize		0B000000
		0050	ckData	(July 13, 2023)	"2023-07-13"00
		005B	(pad)	Padding byte	00
	IART-ck	005C	ckID	IART	49415254
		0060	ckSize		0C000000
		0064	ckData	(creator)	"Taro Yamada"00
	ICOP-ck	0070	ckID	ICOP	49434F50
		0074	ckSize		24000000
		0078	ckData	(copyright)	"Copyright Exif Corporation on 1997."00
exif-LIST		009C	ckID	LIST	4C495354
		00A0	ckSize		64000000
		00A4	listType	exif	65786966
	ever-ck	00A8	ckID	ever	65766572
		00AC	ckSize		04000000
		00B0	ckData	Version 3.0	"0300"
	erel-ck	00B4	ckID	erel	6572656C
		00B8	ckSize		0D000000
		00BC	ckData	(relation to Exif image file)	"DSC00001.JPG"00
		00C9	(pad)	Padding byte	00
	etim-ck	00CA	ckID	etim	6574696D
		00CE	ckSize		0D000000
		00D2	ckData	(10:15:30.130)	"10:15:30.130"00

	00DF	(pad)	Padding byte	00
ecor-ck	00E0	ckID	ecor	65636F72
	00E4	ckSize		10000000
	00E8	ckSize	(manufacturer)	"DSC Corporation"00
emdl-ck	00F8	ckID	emdl	656D646C
	00FC	ckSize		08000000
	0100	ckData	(model)	"DSC1000"00
data-ck	0108	ckID	data	64617461
	010C	ckSize		706C0000
	0110	ckData	PCM Audio Data	00000000000･･････････

(Total samples＝27768)

B.2 μ-Law Audio Data

Table 51 μ-Law Audio File Description Sample Contents

Audio Data	
Format Type	μ-LAW PCM
Channels	monaural
Sampling Frequency	8.000 KHz
Bits per Sample	8 Bits/Sample
Total Samples	111912 Samples
Attribute Information	
Audio Title	“μ-LAW PCM Example”Z
Audio Genre	“Greeting”Z
Recording Date	“2023-07-17”Z
Recording Engineer	“Interactive Multimedia Association”Z
Copyright	“Copyright ABC”Z
Exif-specific Information	
Exif Version	“0300” (Version 3.0)
Related Exif Image File	“DSC00001.JPG”Z
Recording Start Time	“10:20:30.130”Z
Recording Equipment Manufacturer	“ABCD Corporation”Z
Recording Equipment Model	“CameraXYZ”Z
Manufacturer Note	0000000000000000
User Comment	User Comment (ASCII)

Text enclosed in " " is a character string, and ‘Z’ means a character string ending in NULL[00.H]

Table 52 μ-Law Audio File Description Sample

	Offset (Hex)	Name	Comment	Data (Hex or “Ascii”)
RIFF-ck	0000	ckID	RIFF	52494646
	0004	ckSize		A2B60100
	0008	formType	WAVE	57415645
fmt-ck	000C	ckID	fmt[20.H]	666D7420
	0010	ckSize		12000000
	0014	wFormatTag	μ LAW Format	0700
	0016	nchannels	monaural	0100
	0018	nSamplesPerSec	8.000KHz	401F0000
	001C	nAvgBytesPerSec	8000 Bytes/sec	401F0000
	0020	nBlockAlign	1 Byte/block	0100
	0022	wBitsPerSample	8 bits/sample	0800
	0024	cbSize	0	0000
fact-ck	0026	ckID	fact	66616374
	002A	ckSize		04000000
	002E	dwSampleLength		28B50100
INFO-LIST	0032	ckID	LIST	4C495354
	0036	ckSize		A8000000
	003A	listType	INFO	494E464F
INAM-ck	003E	ckID	INAM	494E414D
	0042	ckSize		11000000
	0046	ckData	(audio title)	"uLAW PCM Example"00
	0057	(pad)	Padding byte	00
IGNR-ck	0058	ckID	IGNR	49474E52
	005C	ckSize		09000000
	0060	ckData	(recording genre)	"Greeting"00
	0069	(pad)	Padding byte	00
ICRD-ck	006A	ckID	ICRD	49435244
	006E	ckSize		0B000000
	0072	ckData	(July 17, 2023)	"2023-07-17"00
	007D	(pad)	Padding byte	00
ICMT-ck	007E	ckID	ICMT	49434D54
	0082	ckSize		16000000
	0086	ckData	(comment)	"The uLAW Sample File."00

IART-ck	009C	ckID	IART	49415254
	00A0	ckSize		23000000
	00A4	ckData	(creator)	"Interactive Multimedia Association"00
	00C7	(pad)	Padding byte	00
ICOP-ck	00C8	ckID	ICOP	49434F50
	00CC	ckSize		11000000
	00D0	ckData	(copyright)	"ABCD Corporation"00
	00E1	(pad)	Padding byte	00
exif-LIST	00E2	ckID	LIST	4C495354
	00E6	ckSize		90000000
	00EA	listType	exif	65786966
ever-ck	00EE	ckID	ever	65766572
	00F2	ckSize		04000000
	00F6	ckData	Version 3.0	”0300”
erel-ck	00FA	ckID	erel	6572656C
	00FE	ckSize		0D000000
	0102	ckData	(relation to Exif image file)	"DSC00001.JPG"00
	010F	(pad)	Padding byte	00
etim-ck	0110	ckID	etim	6574696D
	0114	ckSize		0D000000
	0118	ckData	(10:20:30.130)	"10:20:30.130"00
	0125	(pad)	Padding byte	00
ecor-ck	0126	ckID	ecor	65636F72
	012A	ckSize		11000000
	012E	ckSize	(manufacturer)	"ABCD Corporation"00
	013F	(pad)	Padding byte	00
emdl-ck	0140	ckID	emdl	656D646C
	0144	ckSize		0A000000
	0148	ckData	(model)	"CameraXYZ"00
emnt-ck	0152	ckID	emnt	656D6E74
	0156	ckSize		08000000
	015A	ckData	(manufacturer note)	0000000000000000
eucm-ck	0162	ckID	eucm	6575636D
	0166	ckSize		10000000
	016A	ckData	(user comment)	41534349490000005573657220436F6D
data-ck	017A	ckID	data	64617461

	017E	ckSize		28B50100
	0182	ckData	μ-Law Audio Data	F2FE00007FFF0000E3･･･

(Total samples = 111912)

B.3 IMA-ADPCM Audio Data

Table 53 IMA-ADPCM Audio File Description Sample Contents

Audio Data	
Format Type	IMA-ADPCM Format
Channels	stereo
Sampling Frequency	8.000 KHz
Bytes per Block	8110 Bytes/sec
Bits per Sample	4 bits/sample
Total Data Bytes	35840 Bytes
Attribute Information	
Audio Title	“IMA-ADPCM Example”Z
Audio Genre	None
Recording Date	“2023-08-11”Z
Comment	None
Recording Engineer	“Hanako Yamada”Z
Copyright	“Copyright XYZ on 1997.”Z
Exif-specific Information	
Exif Version	“0300” (Version 3.0)
Related Exif Image File	“DSC00001.JPG”Z
Recording Start Time	“15:14:13.135”Z
Recording Equipment Manufacturer	“DSC International Corporation”Z
Recording Equipment Model	“DSC Camera-2”Z
Manufacturer Note	None
User Comment	None

Text enclosed in " " is a character string, and ‘Z’ means a character string ending in NULL[00.H]

Table 54 IMA-ADPCM Audio File Description Example

	Offset (Hex)	Name	Comment	Data (Hex or “Ascii”)
RIFF-ck	0000	ckID	RIFF	52494646
	0004	ckSize		2E8D0000
	0008	formType	WAVE	57415645

fmt-ck	000C	ckID	fmt[20.H]	666D7420
	0010	ckSize		14000000
	0014	wFormatTag	IMA-ADPCM Format	1100
	0016	nchannels	stereo	0200
	0018	nSamplesPerSec	8.000KHz	401F0000
	001C	nAvgBytesPerSec	8110 Bytes/sec	AE1F0000
	0020	nBlockAlign	512 Bytes/block	0002
	0022	wBitsPerSample	4 bits/sample	0400
	0024	cbSize	Additional Bytes＝２	0200
	0026	wSamplesPerBlock	505 Bytes/block	F901
fact-ck	0028	ckID	fact	66616374
	002C	ckSize		04000000
	0030	dwSampleLength	35350 samples	168A0000
INFO-LIST	0034	ckID	LIST	4C495354
	0038	ckSize		7A000000
	003C	listType	INFO	494E464F
INAM-ck	0040	ckID	INAM	494E414D
	0044	ckSize		12000000
	0048	ckData	(audio title)	"IMA-ADPCM Example"00
IGNR-ck	005A	ckID	IGNR	49474E52
	005E	ckSize		09000000
	0062	ckData	(recording genre)	"Greeting"00
	006B	(pad)	Padding byte	00
ICRD-ck	006C	ckID	ICRD	49435244
	0070	ckSize		0B000000
	0074	ckData	(August 11, 2023)	"2023-08-11"00
	007F	(pad)	Padding byte	00
IART-ck	0080	ckID	IART	49415254
	0084	ckSize		0E000000
	0088	ckData	(creator)	"Hanako Yamada"00
ICOP-ck	0096	ckID	ICOP	49434F50
	009A	ckSize		17000000
	009E	ckData	(copyright)	"Copyright XYZ on 1997."00
	00B5	(pad)	Padding byte	00
exif-LIST	00B6	ckID	LIST	4C495354
	00BA	ckSize		78000000

	00BE	listType	exif	65786966
ever-ck	00C2	ckID	ever	65766572
	00C6	ckSize		04000000
	00CA	ckData	Version 3.0	"0300"
erel-ck	00CE	ckID	erel	6572656C
	00D2	ckSize		0D000000
	00D6	ckData	(relation to Exif image file)	"DSC00001.JPG"00
	00E3	(pad)	Padding byte	00
etim-ck	00E4	ckID	etim	6574696D
	00E8	ckSize		0D000000
	00EC	ckData	(15:14:13.135)	"15:14:13.135"00
	00FB	(pad)	Padding byte	00
ecor-ck	00FA	ckID	ecor	65636F72
	00FE	ckSize		1E000000
	0102	ckSize	(manufacturer)	"DSC International Corporation"00
emdl-ck	0120	ckID	emdl	656D646C
	0124	ckSize		0D000000
	0128	ckData	(model)	"DSC Camera-2"00
	0135	(pad)	Padding byte	00
data-ck	0136	ckID	data	64617461
	013A	ckSize		008C0000
	013E	ckData	IMA-ADPCM Audio Data	·····················

(Total Bytes＝35840)

Annex C. [Informative] APEX Units

The camera information in this standard conforms to the APEX (Additive System of Photographic Exposure) unit system. APEX is a convenient unit for expressing exposure (Ev). The relation of APEX to other units is essentially as follows.

```
ApertureValue (Av) = 2 log 2 (F number)

ShutterSpeedValue (Tv) = - log 2 (exposure time)

BrightnessValue (Bv) = log2 ( B/NK )
                    Note that: B:cd/cm2, N,K: constant
```

Film sensitivity (not used in this standard) is expressed as follows.

```
Film sensitivity (Sv) = log2 ( ASA / 3.125 )
```

Using these values, exposure (Ev) is calculated as follows.

```
Ev = Av + Tv = Bv + Sv
```

The table below gives examples of values actually used as camera information.

Table 55 Typical APEX Values

Aperture Value (APEX)	F-Number
0	1
1	1.4
2	2
3	2.8
4	4
5	5.6
6	8
7	11
8	16
9	22
10	32

ShutterSpeed Value (APEX)	ExposureTime (second)
-5	30
-4	15
-3	8
-2	4
-1	2
0	1
1	1/2
2	1/4
3	1/8
4	1/15
5	1/30
6	1/60
7	1/125
8	1/250
9	1/500
10	1/1000
11	1/2000

Brightness Value (APEX)	foot lambert
-2	1/4
-1	1/2
0	1
1	2
2	4
3	8
4	15
5	30

Annex D. [Informative]
Color Space Guidelines

sRGB defines standard monitor color characteristics and viewing environment. The images taken and processed by a DSC should be designed on the premise of being reproduced and viewed in accord with those definitions.

In reality, the recorded data is often saved in a YCC color space because of JPEG compression. It is therefore necessary to clarify the relationship between the above sRGB color space and YCC color space. A definition of this relationship is to be found in the sYCC standard (for which standardization is being advanced in the IEC), and the present standard uses this as reference. One result of referring to the sYCC standard is that colors outside the sRGB color space are included.

Annex E. [Informative] Guidelines for Implementing Tag Information

E.1 General

This chapter gives guidelines for implementing and using the tags defined by the Exif Standard that are of use in print processing (e.g. image retouching). Exif/DCF writers should record these tags as indicated in these guidelines. Exif/DCF readers can make use of the information recorded in Exif file tags in order to perform optimal image processing. Note that the output processing indicated here for Exif/DCF readers are given for the sake of example. Tag IDs and values are given in the explanations. For details, refer to the Exif Standard.

E.2 Tag Use in Exif/DCF Readers

Exif/DCF readers can make use of the information recorded as tags in an Exif file to perform optimal image processing. The following tags are useful for photo retouch processing and their use is to be encouraged whenever possible.

- ExposureMode
- WhiteBalance
- Flash
- SceneCaptureType
- ExposureTime
- CustomRendered

E.2.1 ExposureTime

Tag Information

Exposure time, given in seconds (sec).

[Exif/DCF reader]

- When exposure time is unusually long, the Exif/DCF reader can assume the possibility of noise occurring.
- Other tags (brightness, shutter speed, gain control, captured scene type, etc.) may be used as supplementary information.

E.2.2 BrightnessValue

Tag Information

The value of brightness. The unit is the APEX value.

[Exif/DCF writer]

- The Exif/DCF writer should record the brightness of the presumed main subject. When flash is used, thebrightness level before firing should be recorded.

[Exif/DCF reader]

- The Exif/DCF reader may judge the possibility of noise occurring from very low light conditions.
- This tag may be used to determine the weather conditions, etc., in daylight shooting.

E.2.3 LightSource

Tag Information

Indicates the kind of light source.

[Exif/DCF writer]

- The Exif/DCF writer should record the light source as estimated by the Exif/DCF writer based on white balance, etc., or as set by the user.
- This will sometimes differ from the actual light source used for shooting

[Exif/DCF reader]

- This information may be referred to when adjusting white balance.

E.2.4 Flash

Tag Information

This tag indicates the flash status when the picture was taken.

[Exif/DCF writer]

- The red-eye bit indicates whether the flash was fired for the purpose of red-eye reduction, including pre-flash.
- The red-eye bit can be set when a flash mode for the purpose of reducing red-eye reduction is set.

[Exif/DCF reader]

- This tag can be used along with subject distance range (or subject distance), scene type and brightness to determine whether suitable exposure is possible.

E.2.5 SubjectArea

Tag Information

This tag indicates the location and area of the main subject in the overall scene.

[Exif/DCF writer]

- The Exif/DCF writer should record a subject area that is large enough to enable the Exif/DCF reader to determine the subject, preferably at least one percent of the total image area.

[Exif/DCF reader]

- An Exif/DCF reader can refer to this information as the area for image optimization processing.

E.2.6 CustomRendered

Tag Information

This tag indicates the use of special processing on image data by Exif/DCF writer, such as rendering geared to output. When special processing is performed, the Exif/DCF reader is expected to disable or minimize any further processing.

[Exif/DCF writer]

- For ordinary shooting this is set to 0 (normal process). If the Exif/DCF writer applies special processing such as monochrome mode or sepia mode, and it is desired to prevent or minimize automatic adjustment by the Exif/DCF reader, a value of 1 is set (custom process).
- For ordinary shooting value of 0 is recorded (normal process). If the Exif/DCF writer considers the specific character of output devices, a value of 1 is recorded (custom process).
- When this tag is set to 1 (custom process), vendors should leads users to understand its function.
- Usage cases
  - a) When the user changes exposure or white balance on pursose
  - b) When the user takes pictures using not standard set up but different mode on purpose
  - c) When the user takes pictures using sepia mode or monochrome mode
  - d) When the user chooses soft focus effect
  - e) When the Exif/DCF writer chooses various effects meeting each scene

[Exif/DCF reader]

- When a value of 1 (custom process) is set, the Exif/DCF reader determines that the image has already been specially processed, and should either disable or reduce any further processing in order to prevent double processing.
- Even if a value of 1(custom process) is recorded, basic processing, which depends on each output device, is not needed to be decreased. (See Table 56)

Table 56 Relation between Custom Rendered and Output device process

Tag record value	Basic process	Image data-adaptive process	Tag information-utilized process
Ordinary process	Do	Do	Do
Custom process	Do	No or less	No or less

Basic process : process which depends on the output device.
Image data-adaptive process : Image data correction process which depends on the image data. (brightness retouch, color retouch etc)
Image information-utilized process : Image data correction processing, which depends on the tag information.

E.2.7 ExposureMode

Tag Information

This tag indicates the exposure mode set when the image was shot.

[Exif/DCF writer]

- If shutter speed and aperture were set by the user, the Exif/DCF writer sets a value of 1 (manual exposure); if auto-bracketing was set, a value of 2 (auto bracket) is recorded.
- When exposure bias was set, it is up to the Exif/DCF writer whether to record 0 (auto exposure) or 1 (manual exposure).

[Exif/DCF reader]

- When a value of 0 (auto exposure) is set, an Exif/DCF reader should perform automatic adjustment of exposure settings.
- When a value of 1 (manual exposure) or 2 (auto bracket) is set, the Exif/DCF reader should either not perform automatic bias or should reduce the amount of bias.

E.2.8 WhiteBalance

Tag Information

This tag indicates the white balance set when the image was shot.

[Exif/DCF writer]

- If white balance is determined automatically, 0 (auto white balance) is recorded.
- If preset, custom setting, or while balance auto-bracketing is set, 1 (manual white balance) is recorded.

[Exif/DCF reader]

- If 0 (auto white balance) is recorded, color balance should be adjusted automatically. The Exif/DCF reader may use the light source tag as additional information when performing the adjustment.
- If 1 (manual white balance) is indicated, either normal color balance should not be adjusted automatically or the adjustment level should be reduced.

E.2.9 DigitalZoomRatio

Tag Information

This tag indicates the digital zoom ratio when the image was shot.

[Exif/DCF reader]

- This information can be used as additional information for zoom processing when converting resolution.

E.2.10 FocalLengthIn35mmFilm

Tag Information

This tag indicates the equivalent focal length assuming a 35mm film camera.

[Exif/DCF writer]

- Digital zoom ratio is not taken into account.

[Exif/DCF reader]

- An Exif/DCF reader can use this value along with subject distance to estimate the magnification.

E.2.11 SceneCaptureType

Tag Information

This tag indicates the type of scene that was shot. It can also be used to set the mode in which the image was shot.

[Exif/DCF writer]

- The Exif/DCF writer records the shooting mode set by the user or the scene type determined by the Exif/DCF writer.
- A value of 1 (landscape) indicates a mode suitable for shooting scenery, 2 (portrait) means a mode suitable for portrait photography, and 3(night scene) means a mode suitable for night scenes was set.
- In case of multiple objects in one scene, Exif/DCF writer chooses a value, which suites the main object.
- When the Exif/DCF writer changes the value of contrast, saturation, sharpness, gaincontrol etc, to realize some effects on the photograph, it is better to record the directions.

[Exif/DCF reader]

- The Exif/DCF reader can use this information to perform image processing suitable for the type of scene that was shot.
- The Exif/DCF reader should use this tag and the image analysis result, or other related tags, to prevent over-correction or processing that defeats the purpose of the recorded values.
- If the captured scene type as well as saturation, sharpness and contrast are recorded, it is up to the Exif/DCF reader which of these to use. These tags are recommended to be refered.

Processing examples are given in the table below for each objective.

Table 57 Examples of Processing for Different Scene Types

	Processing Objective	Processing Example
Normal	To make the ordinary scenery look more attractive	Normal processing

Landscape	To make the landscape scenery look more attractive	Enhancement of contrast, saturation, and sharpness
Portrait	To make the subject look more attractive	Memory color correction of skin color
Night Scene	To make the night scene look more attractive	Inhibition of soft tone correction Noise reduction

E.2.12 GainControl

Tag Information

This tag indicates the degree of overall image gain adjustment.

[Exif/DCF writer]

- The Exif/DCF writer records the difference in gain in relation to the default (factory setting) sensitivity. The default sensitivity may differ for each Exif/DCF writer.
- If there is more than one default value, this tag is not used.

[Exif/DCF reader]

- The Exif/DCF reader can estimate the degree of noise occurrence in accord with the recorded value.
- Other tags (exposure time, shutter speed, brightness, captured scene type, etc.) may be used as supplementary information.

E.2.13 Contrast/Saturation/Sharpness

Tag Information

The Contrast tag indicates the direction of contrast processing applied by the camera when the image was shot.

The Saturation tag indicates the direction of saturation processing applied by the camera when the image was shot.

The Sharpness tag indicates the direction of sharpness processing applied by the camera when the image was shot.

[Exif/DCF writer]

- The Exif/DCF writer records the difference in contrast, saturation and sharpness in relation to the default (factory setting) values.
- The defaults may differ for each Exif/DCF writer.
- Regarding the effects matching SceneCaptureType, the Exif/DCF writer should record processing directions by using these tags.

[Exif/DCF reader]

- The Exif/DCF reader should understand that the recorded values are for the purpose of print processing and should avoid over-correction or processing that defeats the purpose of the recorded values.
- Other tags (such as SceneCaptureType) may be used as supplementary information.

Processing examples are given in the table below for each objective.

Table 58 Examples of Processing to be avoided by Exif/DCF Readers

	Processing that goes against the intent of the recorded values	Double processing
Contrast	Softening when hard contrast was intended	Excessive softening when soft contrast is recorded
Saturation	Lowering saturation when high saturation was intended	Raising saturation excessively when high saturation is recorded
Sharpness	Increasing sharpness when weak sharpness was intended	Increasing sharpness excessively when strong sharpness is recorded

E.2.14 SubjectDistanceRange

Tag Information

Indicates the distance range to the subject.

[Exif/DCF writer]

- This is the distance to the part of the scene determined by the Exif/DCF writer to be the main subject. The means of measuring this and the precision are implementation dependent. The camera setting may be recorded.
- When the subject distance range can not be determined, 0 (unknown) shall be recorded.
- When macro mode is set, 1 (macro) shall be recorded.
- Generally if the subject distance is 1 to 3 meters, 2 (close view) shall be recorded.
- If the subject is farther than close range, 3 (distant view) shall be recorded.

[Exif/DCF reader]

- This information can be used as information for processing images shot with flash.
- It can also be used as additional information about the SceneCaptureType.

Annex F. [Informative]
Notes on Conversion to Flashpix

The data recording method in this standard makes it possible to convert from Exif to Flashpix format with no loss of image quality, and retaining all attribute information. A file that is thus designed from the start for conversion to Flashpix is called a Flashpix-Ready (FPXR) file.

There are three main Flashpix-Ready functions:

- All Exif tag information is mapped to the Flashpix Image Info Property Set,
- APP2 extended data can be converted to Flashpix extensions,
- JPEG images can be converted to the Flashpix tile structure without image quality loss, making use of restart markers.

Figure 79 shows the conversion process.

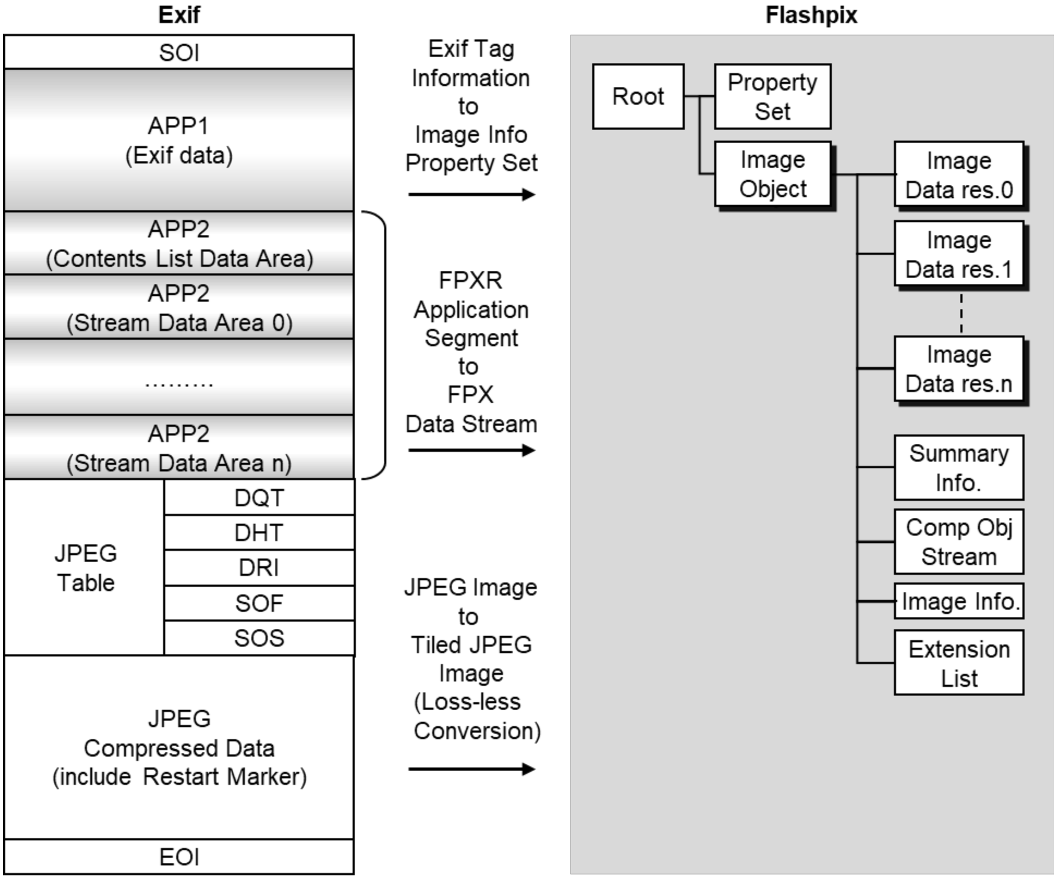
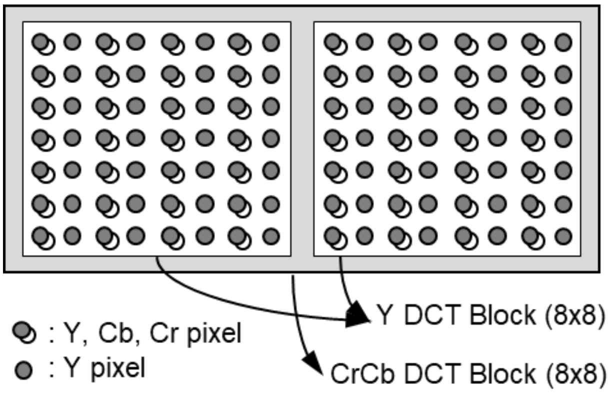


Figure 79 Conversion from Exif to Flashpix

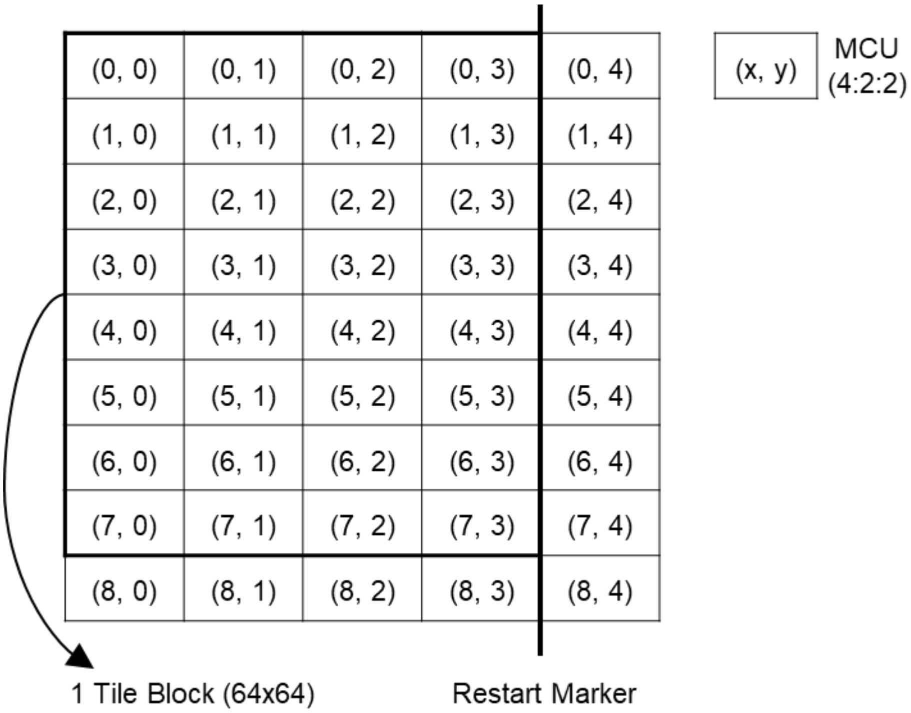
F.1 Converting Image Data

Flashpix compressed image data consists of JPEG-compressed 64 x 64-pixel tiles. Converting JPEG images without restart markers to Flashpix images requires that the JPEG data be expanded and re-compressed, which can lead to image quality loss. By inserting restart markers at 64-pixel interval, Flashpix images of the maximum resolution can be generated simply by rearranging the JPEG-compressed data.

Figure 80 shows how compressed data is rearranged using restart markers.

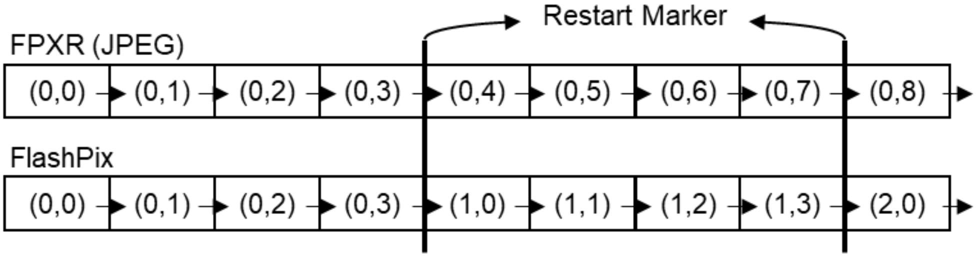


(a) MCU (4:2:2)



(0, 0)	(0, 1)	(0, 2)	(0, 3)	(0, 4)
(1, 0)	(1, 1)	(1, 2)	(1, 3)	(1, 4)
(2, 0)	(2, 1)	(2, 2)	(2, 3)	(2, 4)
(3, 0)	(3, 1)	(3, 2)	(3, 3)	(3, 4)
(4, 0)	(4, 1)	(4, 2)	(4, 3)	(4, 4)
(5, 0)	(5, 1)	(5, 2)	(5, 3)	(5, 4)
(6, 0)	(6, 1)	(6, 2)	(6, 3)	(6, 4)
(7, 0)	(7, 1)	(7, 2)	(7, 3)	(7, 4)
(8, 0)	(8, 1)	(8, 2)	(8, 3)	(8, 4)

(b) Tile Block



(c) Recording order

Figure 80 Conversion to Flashpix Using Restart Markers

Recording of restart markers is optional, and conversion to Flashpix is possible without them; but conversion without restart markers may result in some image quality loss and require a longer processing time.

In order for restart markers to be inserted at 64-pixel interval, the image data width shall be an exact multiple of 64. Therefore the valid image width is recorded as tag information (PixelXDimension), and the JPEG compressed data is recorded with the valid image padded to the right to make it an exact multiple of 64 (see section 4.8.1).

As in the Flashpix standard, padding is used where necessary to achieve exact multiples of 64; and when converting to Flashpix, the padding data on the right can be treated in the same way as valid image data.

If the image height is not an exact multiple of 64, Exif files are not padded; so when converting to Flashpix pad the bottom edge of the image shall be necessary.

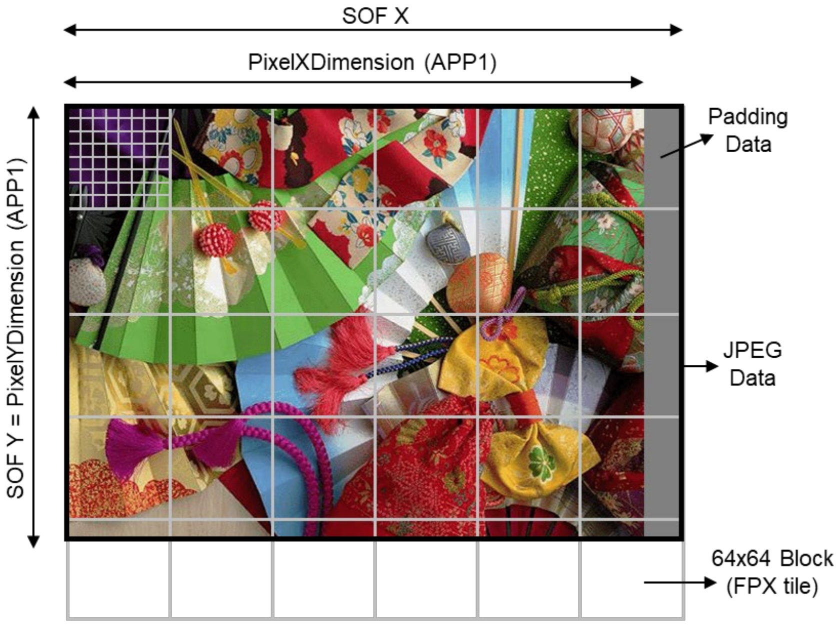


Figure 81 Image Size Restrictions

F.2 Converting Tag Data

When Exif attribute information is converted to Flashpix, a one-to-one conversion can be made to the Property Set used to record Flashpix attributes. The rules for converting from each kind of Exif tag to the Flashpix PropertySet are given in the Table 59 to Table 61 below (conversion of GPS Info tags is to be determined later).

Table 59 Conversion between Exif Tags and Flashpix Property Set (1) (TIFF Tags)

Exif			FPX		
Field Name	Tag Code		Property Set	Group	Name
	Dec	Hex			
ImageWidth	256	100	-	-	-

ImageLength	257	101	-	-	-
BitsPerSample	258	102	-	-	-
Compression	259	103	-	-	-
PhotometricInterpretation	262	106	-	-	-
ImageDescription	270	10E	Image Info	Content Description	Caption text
Make	271	10F	Image Info	Camera Information	Camera manufacturer name
Model	272	110	Image Info	Camera Information	Camera model name
StripOffsets	273	111	-	-	-
Orientation	274	112	Transform	-	Spatial Orientation
SamplesPerPixel	277	115	-	-	-
RowsPerStrip	278	116	-	-	-
StripByteCounts	279	117	-	-	-
XResolution	282	11A	Image Contents	Primary description	Default display width
YResolution	283	11B	Image Contents	Primary description	Default display height
PlanarConfiguration	284	11C	-	-	-
ResolutionUnit	296	128	Image Contents	Primary description	Display height/width units
TransferFunction	301	12D	-	-	-
Software	305	131	Image Info	File source	Software Name
DateTime	306	132	Ignore	Ignore	Ignore
Artist	315	13B	Image Info	Intellectual Property	Authorship
WhitePoint	318	13E	-	-	-
PrimaryChromaticities	319	13F	-	-	-
YCbCrCoefficients	529	211	-	-	-
YCbCrSubSampling	530	212	-	-	-
YCbCrPositioning	531	213	Ignore	Ignore	Ignore
ReferenceBlackWhite	532	214	-	-	-
Copyright	33432	8298	Image Info	Intellectual Property	Copyright message
Exif IFD Pointer	34665	8769	-	-	-
GPS Info IFD Pointer	34853	8825	-	-	-

Table 60 Conversion between Exif Tags and Flashpix Property Set (2) (Exif Private Tags)

Exif			FPX		
Field Name	Tag Code		Property Set	Group	Name
	Dec	Hex			
ExposureTime	33434	829A	Image Info	Per Picture Camera Setting	Exposure time
FNumber	33437	829D	Image Info	Per Picture Camera Setting	F-number

ExposureProgram	34850	8822	Image Info	Per Picture Camera Setting	Exposure program
SpectralSensitivity	34852	8824	Image Info	Digital Camera Characterization	Spectral sensitivity
PhotographicSensitivity	34855	8827	Image Info	Digital Camera Characterization	ISO speed ratings
OECF	34857	8829	Image Info	Digital Camera Characterization	OECF
ExifVersion	36864	9000	-	-	-
DateTimeOriginal	36867	9003	Image Info	Content Description	Date of the original image
			Image Info	Per Picture Camera Setting	Capture date
DateTimeDigitized	36868	9004	Summary Info	-	Create date/time
ComponentsConfiguration	37121	9101	Ignore	Ignore	Ignore
CompressedBitsPerPixel	37122	9102	Ignore	Ignore	Ignore
ShutterSpeedValue	37377	9201	Image Info	Per Picture Camera Setting	Exposure time
ApertureValue	37378	9202	Image Info	Per Picture Camera Setting	F-number
BrightnessValue	37379	9203	Image Info	Per Picture Camera Setting	Brightness value
ExposureBiasValue	37380	9204	Image Info	Per Picture Camera Setting	Exposure bias value
MaxApertureValue	37381	9205	Image Info	Per Picture Camera Setting	Maximum aperture value
SubjectDistance	37382	9206	Image Info	Per Picture Camera Setting	Subject distance
MeteringMode	37383	9207	Image Info	Per Picture Camera Setting	Metering mode
LightSource	37384	9208	Image Info	Per Picture Camera Setting	Scene illuminant
Flash	37385	9209	Image Info	Per Picture Camera Setting	Flash
			Image Info	Per Picture Camera Setting	Flash return
FocalLength	37386	920A	Image Info	Per Picture Camera Setting	Focal length
MakerNote	37500	927C	-	-	-
UserComment	37510	9286	Image Info	Content description	Content description notes
SubSecTime	37520	9290	Ignore	Ignore	Ignore
SubSecTimeOriginal	37521	9291	Image Info	Content Description	Date of the original image
			Image Info	Per Picture Camera Setting	Capture date
SubSecTimeDigitized	37522	9292	Summary Info	-	Create date/time
FlashpixVersion	40960	A000	-	-	-
ColorSpace	40961	A001	Image Contents	resolution description	Subimage color
PixelXDimension	40962	A002	Image Contents	Primary description	Highest resolution width
PixelYDimension	40963	A003	Image Contents	Primary description	Highest resolution height
RelatedSoundFile	40964	A004	-	-	-
FlashEnergy	41483	A20B	Image Info	Per Picture Camera Setting	Flash Energy
SpatialFrequencyResponse	41484	A20C	Image Info	Digital Camera Characterization	Spatial frequency response
FocalplaneXResolution	41486	A20E	Image Info	Digital Camera Characterization	Focal plane X resolution
FocalplaneYResolution	41487	A20F	Image Info	Digital Camera Characterization	Focal plane Y resolution
FocalplaneResolutionUnit	41488	A210	Image Info	Digital Camera Characterization	Focal plane resolution unit

SubjectLocation	41492	A214	Image Info	Per Picture Camera Setting	Subject location
ExposureIndex	41493	A215	Image Info	Per Picture Camera Setting	Exposure index
SensingMethod	41495	A217	Image Info	Digital Camera Characterization	Sensing method
FileSource	41728	A300	Image Info	File Source	File source
SceneType	41729	A301	Image Info	File Source	Scene type
CFAPattern	41730	A302	Image Info	Digital Camera Characterization	CFA pattern

Table 61 Conversion between Exif Tags and Flashpix Property Set (3) (GPS Info Tags)

Exif			**FPX**		
Field Name	**Tag Code**		**Property Set**	**Group**	**Name**
	Dec	**Hex**			
GPSVersionID	0	0	GPS Info extension	-	GPSVersionID
GPSLatitudeRef	1	1	GPS Info extension	-	GPSLatitudeRef
GPSLatitude	2	2	GPS Info extension	-	GPSLatitude
GPSLongitudeRef	3	3	GPS Info extension	-	GPSLongitudeRef
GPSLongitude	4	4	GPS Info extension	-	GPSLongitude
GPSAltitudeRef	5	5	GPS Info extension	-	GPSAltitudeRef
GPSAltitude	6	6	GPS Info extension	-	GPSAltitude
GPSTimeStamp	7	7	GPS Info extension	-	GPSTimeStamp
GPSSatellites	8	8	GPS Info extension	-	GPSSatellites
GPSStatus	9	9	GPS Info extension	-	GPSStatus
GPSMeasureMode	10	A	GPS Info extension	-	GPSMeasureMode
GPSDOP	11	B	GPS Info extension	-	GPSDOP
GPSSpeedRef	12	C	GPS Info extension	-	GPSSpeedRef
GPSSpeed	13	D	GPS Info extension	-	GPSSpeed
GPSTrackRef	14	E	GPS Info extension	-	GPSTrackRef
GPSTrack	15	F	GPS Info extension	-	GPSTrack
GPSImgDirectionRef	16	10	GPS Info extension	-	GPSImgDirectionRef
GPSImgDirection	17	11	GPS Info extension	-	GPSImgDirection
GPSMapDatum	18	12	GPS Info extension	-	GPSMapDatum
GPSDestLatitudeRef	19	13	GPS Info extension	-	GPSDestLatitudeRef
GPSDestLatitude	20	14	GPS Info extension	-	GPSDestLatitude
GPSDestLongitudeRef	21	15	GPS Info extension	-	GPSDestLongitudeRef
GPSDestLongitude	22	16	GPS Info extension	-	GPSDestLongitude
GPSDestBearingRef	23	17	GPS Info extension	-	GPSDestBearingRef
GPSDestBearing	24	18	GPS Info extension	-	GPSDestBearing

GPSDestDistanceRef	25	19	GPS Info extension	-	GPSDestDistanceRef
GPSDestDistance	26	1A	GPS Info extension	-	GPSDestDistance

F.3 Converting to Flashpix Extensions (APP2)

The extended data recorded in APP2 marker segments can be converted readily to Flashpix extensions.

First of all, Figure 82 shows the conversion process when APP2 is recorded as one entry per stream of data. An area with data size of 8000.H, Default value 00.H is allocated to the stream name "/\005MyPropertySet" (\005 means 005.H) in the Flashpix file Structured Storage structure, and the stream data recorded in APP2-2 is copied to offset 00000000.H, that is, the start of the allocated area.

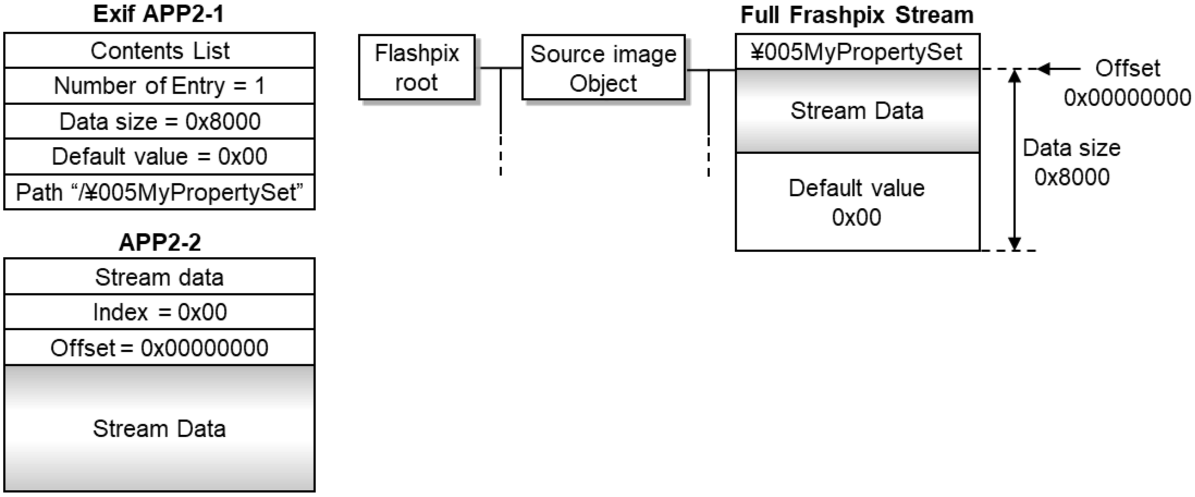


Figure 82 Conversion to Flashpix Extensions (1)

Next, Figure 83 shows the conversion process when one entry per two streams of data is recorded in APP2. This time an area with data size of 10000.H, Default value 00.H is allocated to the stream name "/\005MyPropertySet" in the Flashpix file Structured Storage structure, and the stream data recorded in APP2-2 is copied to offset 00000000.H, that is, the start of the allocated area, while the stream data recorded in APP2-3 is copied starting from offset 00008000.H.

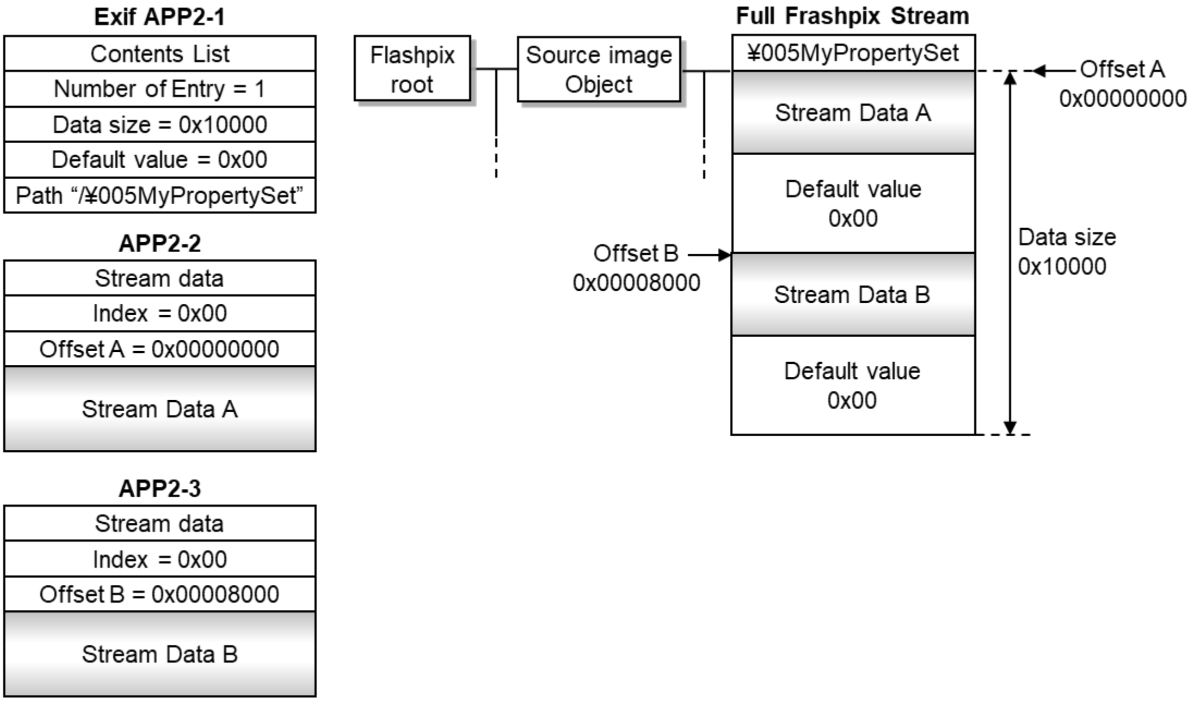


Figure 83 Conversion to Flashpix Extensions (2)

Finally, Figure 84 shows an example of conversion when 2 entry per stream of data are recorded in APP2.

In the Structured Storage of Flashpix file, an area with a data size of 8000.H and a Default value of 00.H is allocated to the stream name " MyPropertySet" in the lower layer of the storage name "\005MyStorage", and the stream data recorded in APP2-2 may be copied to the area starting from the offset 00000000.H that is the beginning of the allocated area.

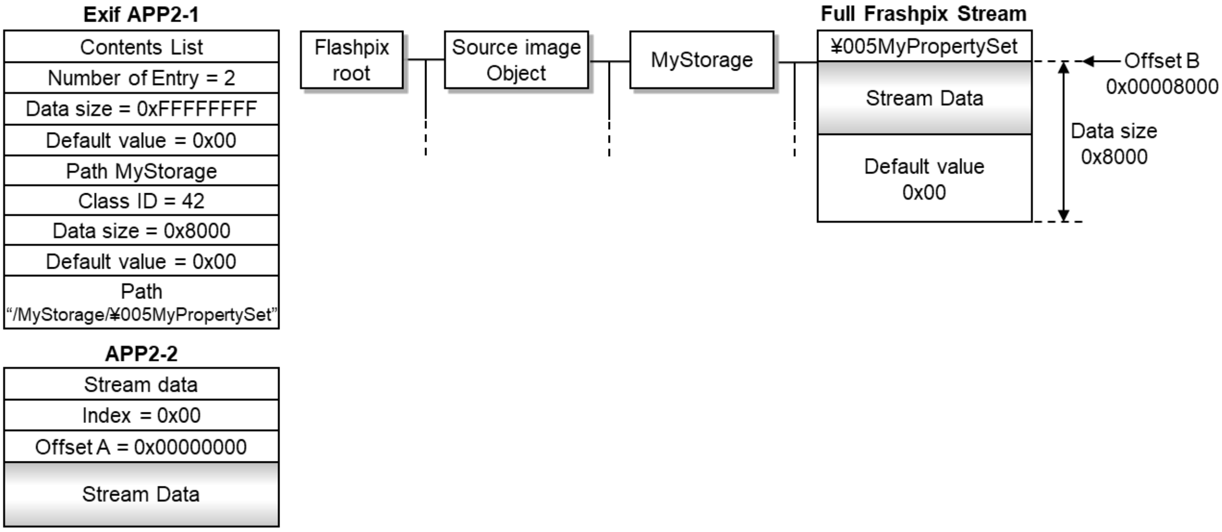


Figure 84 Conversion to Flashpix Extensions (3)

Annex G. [Informative]
Use of Sensitivity-Related Tags

"Sensitivity-related tags" refer generally to seven tags: PhotographicSensitivity, SensitivityType, StandardOutputSensitivity, RecommendedExposureIndex, ISO Speed, ISOSpeedLatitudeyyy, and ISOSpeedLatitudezzz.

The current specifications of sensitivity-related tags resulted from consideration of a couple of circumstances. First, the PhotographicSensitivity tag whose ID was 34855 was previously referred to as ISOSpeedRating, which, in reality, led to confused interpretations of sensitivity that resulted in many recordings that differed from ISO speed as defined under the ISO 12232[11] standard. Second, sensitivity parameters were added to ISO 12232[11] as a result of a 2006 revision.

The PhotographicSensitivity tag records the sensitivity of the camera or input device when the image of the relevant file was taken. And the parameter that can be recorded as sensitivity here is a value for one of the following, all of which are defined in ISO 12232[11]: standard output sensitivity (SOS), recommended exposure index (REI), and ISO speed.

For the PhotographicSensitivity tag is an existing tag from Version 2.21 and earlier versions though its name and definition has changed, it is expected that its digit number will become insufficient to match the advancing sensitivity of cameras because its Type is SHORT. However, in the case that the sensitivity value to be noted is 65535 (the maximum value of SHORT) or higher, it records a value of 65535. Thus it is desirable for the file reader to read this value and then move on to read the values in related tags that correspond to the types that were designated by the SensitivityType tag. (Readers corresponding to Version 2.21 and earlier versions simply interpret this sensitivity value as having reached the upper limit.)

In other words, in the case that only one sensitivity parameter is used and digit number is sufficient, it is possible to record sensitivity by using only the existing PhotographicSensitivity tag (and the newly defined SensitivityTYPE tag). (Although using Count = 1 is first principle, this is only recommended and "Any" is continued as a specification based on consideration for interoperability.)

SensitivityTYPE tag indicates which one of the three kinds of parameters of ISO12232 is the PhotographicSensitivity. However, these three parameters sometimes can take the same numerical values depending on the camera's gradation and exposure characteristics, Value = 4, 5, 6, or 7 may be used in such cases. At the same time, Value = 1, 2, or 3 shoud be used in case that the same numerical value is coincidentally occurred and only one kind of difinition is contemplating camera design. Furthermore, in case of the camera compliant with CIPA standard DC-004 (sensitivity of digital cameras), it is necessary to use either SOS or REI in the sensitivity notation, and therefore one of value = 1, 2, 4, 5, 6, or 7 is used. And when type is unknown (for example, in case of handling a file recorded by a camera that applies to Version 2.21 or earlier), then value = 0 should be used. (As a rule, the SensitivityType tag is also recorded when the PhotographicSensitivity tag is recorded; however, this is only recommended due to consideration for interoperability.)

On the tags of StandardOutputSensitivity, RecommendedExposureIndex and ISOSpeed, numerical values for the tags should be noted in accordance with their definitions respectively, however, when recording even just one of the three tags, it is necessary to record the PhotographicSensitivity tag and SensitivityType tag because it means that a sensitivity parameter is recorded in this case. (The three tags do not exist for Version 2.21 and earlier; therefore recording is possible if a device corresponds to one of the three tags.)

On ISOSpeedLatitudeyyy and ISOSpeedLatitudezzz tags, numerical values for the tags should be recorded in accordance with their definitions. However, using these tags on their own is prohibited because they are incidental parameters of ISO speed.

Annex H. [Informative]
Guidelines for Handling Tag Information in Post-processing by Application Software

H.1 Introduction

Exif images are effectively utilized in various industries and in various situations, and the information in Exif tag groups (metadata), which are correctly recorded with the images, is very important in processing by application software (hereinafter referred to as "post-processing").

On the other hand, there is risk that sensitive information about individuals or organizations may be identified or inferred when the images are publicly posted on SNS or the like (especially for photographs taken with smartphones) if GPS information or the like is included in the Exif tags. In order to avoid this risk, the entire Exif tag is deleted, even information unrelated to the sensitive information about individuals or organizations. One of the reasons for this is that this specification lists Exif tag groups with various purposes without any particular classification, making it difficult for users to understand which tags are necessary or useful for post-processing and which tags are associated with sensitive information, such as individual or organization related information. This annex therefore classifies the Exif tag groups and presents the classifications.

Preferably, the handling of tags in post-processing is performed in accordance with this annex.

H.2 Exif Tag Classifications

Table 62, Exif tags are classified into three categories based on positioning.

Table 62 Exif Tag Classifications

Classification	Definition	Description
Category Ⅰ	Image structure related metadata (including color space information and the like)	A group of tags indicating image structure, such as image size (Width, Height). This information is necessary during image display, and related tags needs to be updated at the time of image editing.
Category Ⅱ	Shooting condition related metadata (image capture setting conditions)	A group of tags that record camera setting information during image capture, such as the shutter speed and lens aperture value. The information is information during image capture, and thus need not be updated or deleted unless special circumstances exist.

Category III	Metadata storing other information	A group of tags describing various information other than that of Category I/II, such as the camera model name, serial number, image capture date and time, image capture location, owner name, and copyrights.

H.3 Post-processing Ranks of Exif Tags

Table 63 defines policy-based ranks on the handling of each tag in post-processing. The ranks are divided into Update (for Exif tags to be updated with each image update) and Freeze (for Exif tags that do not require updating or deletion, in principle). These ranks are then further subdivided into Update 0 and Update 1 and Freeze 0, Freeze 1, and Freeze 2, respectively, to accommodate cases in which modification, deletion, or the like is possible.

Table 63 Post-processing Ranks

Rank	Definition	Description
Update		
Update 0	Shall be updated with image structure change	Information that should be updated as necessary during image editing, such as tags expressing image structure (+ file structure) and tags expressing color space
Update 1	Can be updated regardless of image structure change	Information updated regardless of image editing; varous information tags.
Freeze		
Freeze 0	Shall not be deleted/updated at any time	Information that shall not be deleted or updated under any circumstance; tags not associated with sensitive information related to individuals, organizations, etc. (proof of image uniqueness, etc.)

Freeze 1	Can be deleted in special cases	Special circumstances here refer to cases in which an individual or organization or a time and location is identified by recorded tag information, resulting in a damage to them. In such circumstances, the related tag information can be deleted. Corresponding cases include, for example, ensuring the safety of combat photographers, protecting personal privacy, etc.
Freeze 2	Can be corrected [if wrong], added [if empty] or deleted [in special cases]	Information that can be corrected during post-processing if inaccurate or left blank; time, location, and other tags. Information that can be deleted under special circumstances.

H.4 Category and Rank Relationship

All tags belonging to Category I (image structure) of the classifications defined in section H.2 should be updated every time the image is edited, and are thus ranked Update 0. On the other hand, all tags belonging to Category II (image capture setting conditions) do not need to be updated and are thus ranked Freeze 1.

Although SubjectArea/SubjectLocation are tags expressing the "location/area of the main subject" and therefore correspond to Category II (image capture setting conditions) and Freeze 2, relative location information requires updating when the image size or the like is changed and therefore the tags are classified as Category I/II and ranked as Update 0.

The ranks of the group of tags in Category III (other information) differ depending on positioning, and are thus organized as follows.

ImageUniqueID :

This tag is an important tag that proves the uniqueness of the image and is useful as a countermeasure for fake information if the tag information securely remains with the image. This tag can not be deleted or modified under any circumstance and is only ranked Freeze 0.

Make・Model・BodySerialNumber :

These tags are invariant values recorded before the image is taken, do not need to be deleted or modified except under special circumstances as described in section H.3, and are thus ranked Freeze 1.

DateTimeOriginal・OffsetTimeOriginal・SubSecTimeOriginal :

Among the two main types of tags that record time when a DSC image is taken, these tags record the original recording time when the original image was generated (as tags that record the respective digitized times, DateTimeDigitized, OffsetTimeDigitized, and SubSecTimeDigitized are also included) and are ranked Freeze 2 to allow correction in case of error.

In addition to these six time information related tags (DateTimeOriginal, DateTimeDigitized, etc.), the following tags are also ranked Freeze 2, totaling 52 tags with this rank:

- Thirty-two position information related tags (GPS Info Tags)
- Six image capture condition related tags (Temperature, Humidity, Pressure, WaterDepth, Acceleration, CameraElevationAngle)
- Four lens information related tags (LensSpecification, LensMake, LensModel, LensSerialNumber)
- Four name description related tags (CameraOwnerName, Photographer, CameraFirmware, RAWDevelopingSoftware)

DateTime・OffsetTime・SubSecTime :

Among the main two types of tags that record time when a DCS image is taken, these tags record the final time after editing and the like in post-processing. These tags are ranked Update 0 and are updated with every edit.

ImageDescription ・ Software ・ Artist ・ Copyright ・ UserComment ・ ImageTitle ・ ImageEditor ・ ImageEditingSoftware・MetadataEditingSoftware :

This is a group of Exif tags that may be added or edited in post-processing. The Exif tags can be updated alone regardless of changes in image structure, and are thus ranked Update 1.

H.5 Possibility of Identifying or Inferring Sensitive Information Related to Individuals, Organizations, etc.

The group of image structure related tags described in Category I constitute information required for proper image display and, in principle, can not be deleted. In addition, these tags do not include information that can be used to identify individuals or organizations, and thus these tags need not to be deleted.

The group of image capture setting information tags described in Category II are not associated with sensitive information related to individuals, organizations, or the like, and thus, in principle, do not need to be deleted. However, when an image is taken under special shooting conditions (shutter speed for high-speed shooting or sensitivity settings for darkroom shooting, for example) there is a possibility that the camera model can be identified from tag descriptions. If there are special circumstances as described in H.3, the tag can be deleted and thus the rank is set to Freeze 1 instead of Freeze 0.

Other information tags described in Category III constitute important information when proof of original is required, and are preferably transmitted to application software in a subsequent stage without being deleted. On the other hand, all Category III tags (time, location, name, image capture conditions, etc.) other than ImageUniqueID are assumed to be associated with sensitive information related to individuals, organizations, etc. Therefore, care should be taken to delete the tags when it is necessary to avoid identification or inferrence of sensitive information related to individuals, organizations, or the like.

H.6 Tag Categories and Ranks

Table 64 to Table 67 list the tag categories and ranks.

Table 64 Categories and Ranks of 0th IFD TIFF Tags

Fieldname	Tag ID		Category	Rank
	Dec	Hex		
ImageWidth	256	100	Category Ⅰ	Update 0
ImageLength	257	101	Category Ⅰ	Update 0
BitsPerSample	258	102	Category Ⅰ	Update 0
Compression	259	103	Category Ⅰ	Update 0
PhotometricInterpretation	262	106	Category Ⅰ	Update 0
ImageDescription	270	10E	Category Ⅲ	Update 1
Make	271	10F	Category Ⅲ	Freeze 1
Model	272	110	Category Ⅲ	Freeze 1
StripOffsets	273	111	Category Ⅰ	Update 0
Orientation	274	112	Category Ⅰ	Update 0
SamplesPerPixel	277	115	Category Ⅰ	Update 0
RowsPerStrip	278	116	Category Ⅰ	Update 0
StripByteCounts	279	117	Category Ⅰ	Update 0
XResolution	282	11A	Category Ⅰ	Update 0
YResolution	283	11B	Category Ⅰ	Update 0
PlanarConfiguration	284	11C	Category Ⅰ	Update 0
ResolutionUnit	296	128	Category Ⅰ	Update 0
TransferFunction	301	12D	Category Ⅰ	Update 0
Software	305	131	Category Ⅲ	Update 1
DateTime	306	132	Category Ⅲ	Update 0
Artist	315	13B	Category Ⅲ	Update 1
WhitePoint	318	13E	Category Ⅰ	Update 0
PrimaryChromaticities	319	13F	Category Ⅰ	Update 0
JPEGInterchangeFormat	513	201	Category Ⅰ	Update 0

JPEGInterchangeFormatLength	514	202	Category Ⅰ	Update 0
YCbCrCoefficients	529	211	Category Ⅰ	Update 0
YCbCrSubSampling	530	212	Category Ⅰ	Update 0
YCbCrPositioning	531	213	Category Ⅰ	Update 0
ReferenceBlackWhite	532	214	Category Ⅰ	Update 0
Copyright	33432	8298	Category Ⅲ	Update 1
Exif IFD Pointer	34665	8769	Category Ⅰ	Update 0
GPSInfo IFD Pointer	34853	8825	Category Ⅰ	Update 0

Table 65 Categories and Ranks of 0th IFD Exif Private Tags

Fieldname	TagID		Category	Rank
	Dec	Hex		
ExposureTime	33434	829A	Category Ⅱ	Freeze 1
FNumber	33437	829D	Category Ⅱ	Freeze 1
ExposureProgram	34850	8822	Category Ⅱ	Freeze 1
SpectralSensitivity	34852	8824	Category Ⅱ	Freeze 1
PhotographicSensitivity	34855	8827	Category Ⅱ	Freeze 1
OECF	34856	8828	Category Ⅱ	Freeze 1
SensitivityType	34864	8830	Category Ⅱ	Freeze 1
StandardOutputSensitivity	34865	8831	Category Ⅱ	Freeze 1
RecommendedExposureIndex	34866	8832	Category Ⅱ	Freeze 1
ISOSpeed	34867	8833	Category Ⅱ	Freeze 1
ISOSpeedLatitudeyyy	34868	8834	Category Ⅱ	Freeze 1
ISOSpeedLatitudezzz	34869	8835	Category Ⅱ	Freeze 1
ExifVersion	36864	9000	Category Ⅱ	Freeze 1
DateTimeOriginal	36867	9003	Category Ⅲ	Freeze 2
DateTimeDigitized	36868	9004	Category Ⅲ	Freeze 2
OffsetTime	36880	9010	Category Ⅲ	Update 0
OffsetTimeOriginal	36881	9011	Category Ⅲ	Freeze 2
OffsetTimeDigitized	36882	9012	Category Ⅲ	Freeze 2
ComponentsConfiguration	37121	9101	Category Ⅰ	Update 0
CompressedBitsPerPixel	37122	9102	Category Ⅰ	Update 0
ShutterSpeedValue	37377	9201	Category Ⅱ	Freeze 1
ApertureValue	37378	9202	Category Ⅱ	Freeze 1
BrightnessValue	37379	9203	Category Ⅱ	Freeze 1
ExposureBiasValue	37380	9204	Category Ⅱ	Freeze 1

MaxApertureValue	37381	9205	Category Ⅱ	Freeze 1
SubjectDistance	37382	9206	Category Ⅱ	Freeze 1
MeteringMode	37383	9207	Category Ⅱ	Freeze 1
LightSource	37384	9208	Category Ⅱ	Freeze 1
Flash	37385	9209	Category Ⅱ	Freeze 1
FocalLength	37386	920A	Category Ⅱ	Freeze 1
SubjectArea	37396	9214	Category Ⅰ/Ⅱ	Update 0
MakerNote	37500	927C	Category Ⅱ	Freeze 1
UserComment	37510	9286	Category Ⅲ	Update 1
SubSecTime	37520	9290	Category Ⅲ	Update 0
SubSecTimeOriginal	37521	9291	Category Ⅲ	Freeze 2
SubSecTimeDigitized	37522	9292	Category Ⅲ	Freeze 2
Temperature	37888	9400	Category Ⅲ	Freeze 2
Humidity	37889	9401	Category Ⅲ	Freeze 2
Pressure	37890	9402	Category Ⅲ	Freeze 2
WaterDepth	37891	9403	Category Ⅲ	Freeze 2
Acceleration	37892	9404	Category Ⅲ	Freeze 2
CameraElevationAngle	37893	9405	Category Ⅲ	Freeze 2
FlashpixVersion	40960	A000	Category Ⅱ	Freeze 1
ColorSpace	40961	A001	Category Ⅰ	Update 0
PixelXDimension	40962	A002	Category Ⅰ	Update 0
PixelYDimension	40963	A003	Category Ⅰ	Update 0
RelatedSoundFile	40964	A004	Category Ⅰ	Update 0
Interoperability IFD Pointer	40965	A005	Category Ⅰ	Update 0
FlashEnergy	41483	A20B	Category Ⅱ	Freeze 1
SpatialFrequencyResponse	41484	A20C	Category Ⅱ	Freeze 1
FocalPlaneXResolution	41486	A20E	Category Ⅱ	Freeze 1
FocalPlaneYResolution	41487	A20F	Category Ⅱ	Freeze 1
FocalPlaneResolutionUnit	41488	A210	Category Ⅱ	Freeze 1
SubjectLocation	41492	A214	Category Ⅰ/Ⅱ	Update 0
ExposureIndex	41493	A215	Category Ⅱ	Freeze 1
SensingMethod	41495	A217	Category Ⅱ	Freeze 1
FileSource	41728	A300	Category Ⅱ	Freeze 1
SceneType	41729	A301	Category Ⅱ	Freeze 1
CFAPattern	41730	A302	Category Ⅱ	Freeze 1
CustomRendered	41985	A401	Category Ⅱ	Freeze 1

ExposureMode	41986	A402	Category Ⅱ	Freeze 1
WhiteBalance	41987	A403	Category Ⅱ	Freeze 1
DigitalZoomRatio	41988	A404	Category Ⅱ	Freeze 1
FocalLengthIn35mmFilm	41989	A405	Category Ⅱ	Freeze 1
SceneCaptureType	41990	A406	Category Ⅱ	Freeze 1
GainControl	41991	A407	Category Ⅱ	Freeze 1
Contrast	41992	A408	Category Ⅱ	Freeze 1
Saturation	41993	A409	Category Ⅱ	Freeze 1
Sharpness	41994	A40A	Category Ⅱ	Freeze 1
DeviceSettingDescription	41995	A40B	Category Ⅱ	Freeze 1
SubjectDistanceRange	41996	A40C	Category Ⅱ	Freeze 1
ImageUniqueID	42016	A420	Category Ⅲ	Freeze 0
CameraOwnerName	42032	A430	Category Ⅲ	Freeze 2
BodySerialNumber	42033	A431	Category Ⅲ	Freeze 1
LensSpecification	42034	A432	Category Ⅲ	Freeze 2
LensMake	42035	A433	Category Ⅲ	Freeze 2
LensModel	42036	A434	Category Ⅲ	Freeze 2
LensSerialNumber	42037	A435	Category Ⅲ	Freeze 2
CompositeImage	42080	A460	Category Ⅱ	Freeze 1
SourceImageNumberOfCompositeImage	42081	A461	Category Ⅱ	Freeze 1
SourceExposureTimesOfCompositeImage	42082	A462	Category Ⅱ	Freeze 1
Gamma	42240	A500	Category Ⅰ	Update 0
ImageTitle	42038	A436	Category Ⅲ	Update 1
Photographer	42039	A437	Category Ⅲ	Freeze 2
ImageEditor	42040	A438	Category Ⅲ	Update 1
CameraFirmware	42041	A439	Category Ⅲ	Freeze 2
RAWDevelopingSoftware	42042	A43A	Category Ⅲ	Freeze 2
ImageEditingSoftware	42043	A43B	Category Ⅲ	Update 1
MetadataEditingSoftware	42044	A43C	Category Ⅲ	Update 1

Table 66 Categories and Ranks of 0th IFD GPS Info Tags

Fieldname	Tag ID		Category	Rank
	Dec	Hex		
GPSVersionID	0	0	Category Ⅲ	Freeze 2
GPSLatitudeRef	1	1	Category Ⅲ	Freeze 2
GPSLatitude	2	2	Category Ⅲ	Freeze 2

GPSLongitudeRef	3	3	Category Ⅲ	Freeze 2
GPSLongitude	4	4	Category Ⅲ	Freeze 2
GPSAltitudeRef	5	5	Category Ⅲ	Freeze 2
GPSAltitude	6	6	Category Ⅲ	Freeze 2
GPSTimeStamp	7	7	Category Ⅲ	Freeze 2
GPSSatellites	8	8	Category Ⅲ	Freeze 2
GPSStatus	9	9	Category Ⅲ	Freeze 2
GPSMeasureMode	10	A	Category Ⅲ	Freeze 2
GPSDOP	11	B	Category Ⅲ	Freeze 2
GPSSpeedRef	12	C	Category Ⅲ	Freeze 2
GPSSpeed	13	D	Category Ⅲ	Freeze 2
GPSTrackRef	14	E	Category Ⅲ	Freeze 2
GPSTrack	15	F	Category Ⅲ	Freeze 2
GPSImgDirectionRef	16	10	Category Ⅲ	Freeze 2
GPSImgDirection	17	11	Category Ⅲ	Freeze 2
GPSMapDatum	18	12	Category Ⅲ	Freeze 2
GPSDestLatitudeRef	19	13	Category Ⅲ	Freeze 2
GPSDestLatitude	20	14	Category Ⅲ	Freeze 2
GPSDestLongitudeRef	21	15	Category Ⅲ	Freeze 2
GPSDestLongitude	22	16	Category Ⅲ	Freeze 2
GPSDestBearingRef	23	17	Category Ⅲ	Freeze 2
GPSDestBearing	24	18	Category Ⅲ	Freeze 2
GPSDestDistanceRef	25	19	Category Ⅲ	Freeze 2
GPSDestDistance	26	1A	Category Ⅲ	Freeze 2
GPSProcessingMethod	27	1B	Category Ⅲ	Freeze 2
GPSAreaInformation	28	1C	Category Ⅲ	Freeze 2
GPSDateStamp	29	1D	Category Ⅲ	Freeze 2
GPSDifferential	30	1E	Category Ⅲ	Freeze 2
GPSHPositioningError	31	1F	Category Ⅲ	Freeze 2

Table 67 Categories and Ranks of 0th IFD Interoperability Tag

Fieldname	Tag ID		Category	Rank
	Dec	Hex		
InteroperabilityIndex	1	1	Category Ⅰ	Update 0

Annex I. [Informative] Vocabulary Specifications

The vocabulary used as annotation data can be broadly divided into free vocabulary and controlled vocabulary. Descriptions using controlled vocabulary can reduce vocabulary fluctuations and improve the uniqueness of the interpretation of the annotation data. This promotes the effective use of annotation data. On the other hand, controlled vocabulary has the disadvantage that the contents that can be described are predetermined and thus limited.

Free descriptions have the opposite advantages and disadvantages of those of the controlled terminology described above.

From the viewpoint of effective utilization of annotation data across industries, preferably syntax as well as vocabulary are standardized. The controlled terminology for general annotation data is defined by organizations such as the following:

IMI(Infrastructure for Multilayer Interoperability) (https://imi.go.jp/goi/)

The Dublin Core™ Metadata Initiative (http://purl.org/dc/elements/1.1/)

The World Wide Web Consortium (http://www.w3.org/ns/dcat#)

The following table compares the overlap (coverage) of the controlled vocabulary determined by the above organizations in relation to the terminology expected to be used in this specification.

Table 68 Overlap of Controlled Terminology Established by Major Organizations

Controlled Terminology (Attribute)	IMI Vocabulary	DublinCore™	DataCatalog Vocabulary
Area ID	◎	◎	◎
Title	◎	◎	◎
Keyword	◎	◎	◎
Object name	◎	◎	◎
Rights informaiton	◎	◎	◎
Recorded date and	◎	◎	◎
Intended use of	◎	◎	×
Edited date and	×	×	◎

◎: Specifications similar to attribute

×: No specifications

This comparison of representative controlled vocabulary shows that many vocabulary words are already specified.

On the other hand, there is also industry-specific vocabulary. Without the ability to write annotation using industry-specific vocabulary, the effectiveness of the annotation data platform is limited. In addition, vocabulary already defined for each industry or commonly used within the industry may have different meanings from other industries. Thus, such vocabulary can be broadly classified into two categories: vocabulary common across industries and vocabulary unique to each industry.

For these reasons, in this standard, vocabulary indicating areas and positions in an image, which is essential to the configuration of the standard, is specified using controlled vocabulary. Further, for general vocabulary and the vocabulary used in each industry, already specified controlled vocabulary is used.

Annex J. [Informative]
Examples of Annotation Description

J.1 Description Examples

The following provides specific description examples of annotation defined in this standard.

The image used for the description examples is shown below.

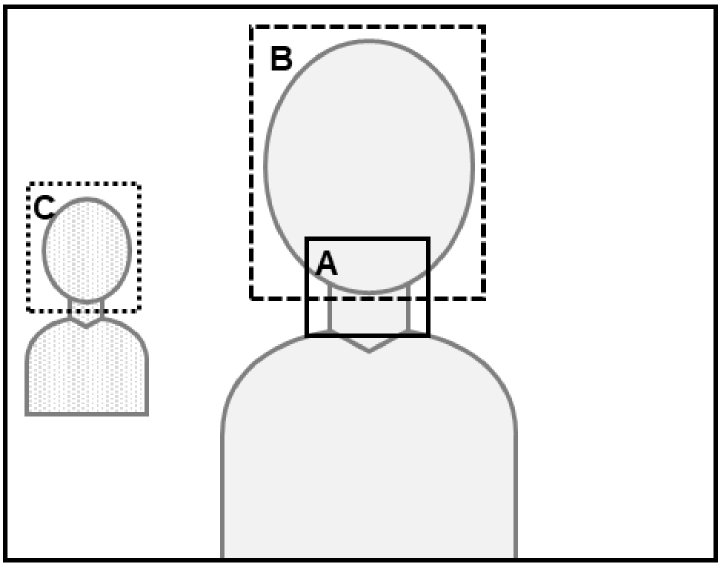


Figure 85 Annotation Description Sample Image

This image shows two persons in the field of view with the focus on the person in the center. The camera detects two faces at the time of image capture.

The information of areas A to C in the image is as follows:

Image size:

Width	3000
Height	2000

Area A:

Coordinates	Upper left: (1200, 800), Lower right: (1800, 1200)
Description	Auto focus frame

Area B:

Coordinates	Upper left: (1010, 110), Lower right: (2010, 910)
Description	Face of person 1 detected by camera

Area C:

Coordinates	Upper left: (220, 620), Lower right: (520, 920)
Description	Face of person 2 detected by camera

J.2 Example of Description in JSON-LD Form

The following is an example of the description of the image size, areas A to C, and the camera imaging information of Figure 85 in JSON-LD form.

```
{
    "@context" : {
        "exifEX": "http://cipa.jp/exif/2.32/",
        "exif": "http://ns.adobe.com/exif/1.0/",
        "dc": "http://purl.org/dc/elements/1.1/",
        "tiff": "http://ns.adobe.com/tiff/1.0/"
    },
    exifEX:ExifAN{
        "exifEX:ANW":3000,
        "exifEX:ANH":2000,
        {
            "exifEX:rectangle":{"UX":1200,"UY":800,"BX":1800,"BY":1200},
            "dc:description":"Auto focus frame"
        },
        {
            "exifEX:rectangle":{"UX":1010,"UY":110,"BX":2010,"BY":910},
            "dc:description":"Face of person 1 detected by camera"
        },
        {
            "exifEX:rectangle":{"UX": 220,"UY":620,"BX":520,"BY":920},
            "dc:description":"Face of person 2 detected by camera"
        }
    }
}
```

Figure 86 Example of JSON-LD

Lines 3 to 6 following @context of line 2 define the namespaces of exifEX, exif, dc, and tiff, respectively.

The content written in { } of exifEX:ExifAN in line 10 is the area that conforms to this standard and the attached information. Line 10 and line 11 describe the width and height of the image, including the coordinates, size, and the like of the area as a reference, line 12 to line 15 describe area A, line 16 to line 19 describe area B, and line 20 to line 23 describe area C.

In the description of each area, the rectangle representing the rectangle area and its coordinates are described in the first line, and attached information of the area is described in subsequent lines.

J.3 Example of Description in XML Form

The following is an example of a description of the image size, areas A to C, and the camera imaging information of Figure 85 in XML form.

```
<?xml version="1.0" encoding="UTF-8" ?>
<exifEX:ExifAN
  xmlns:exifEX="http://cipa.jp/exif/2.32/"
  xmlns:exif="http://ns.adobe.com/exif/1.0/"
  xmlns:dc="http://purl.org/dc/elements/1.1/"
  xmlns:tiff="http://ns.adobe.com/tiff/1.0/">

  <exifEX:ANW>3000</exifEX:ANW>
  <exifEX:ANH>2000</exifEX:ANH>

  <region>
      <exifEX:rectangle>
         <UX>1200</UX>
         <UY>800</UY>
         <BX>1800</BX>
         <BY>1200</BY>
      </exifEX:rectangle>
      <dc:description>"Auto focus frame"</dc:description>
  </region>

  <region>
      <exifEX:rectangle>
         <UX>1010</UX>
         <UY>110</UY>
         <BX>2010</BX>
         <BY>910</BY>
      </exifEX:rectangle>
      <dc:description>"Face of person 1 detected by camera"</dc:description>
  </region>
  <region>
     <exifEX:rectangle>
        <UX>220</UX>
        <UY>620</UY>
        <BX>520</BX>
        <BY>920</BY>
     </exifEX:rectangle>
     <dc:description>"Face of person 2 detected by camera"</dc:description>
  </region>
</exifEX:ExifAN>
```

Figure 87 Example of XML

The contents described in the <exifEX:ExifAN> tag in line 3 and the </exifEX:ExifAN> tag in line 40 are areas that conform to this standard and the attached information.

Line 4 to line 7 define the namespaces of exifEX, exif, dc, and tiff, respectively.

Line 9 and line 10 describe the width and height of the image, including the coordinates, size, and the like of the subsequent areas, line 12 to line 20 describe area A, line 21 to line 29 describe area B, and line 30 to line 38 describe area C.

A region tag such as in line 12 is a tag used to describe an area. As the tag name, any name can be used, not only region, but item or the like as well.

In each area, the portion between the <exifEX:rectangle> tag indicating a rectangle area and the </exifEX:rectangle> tag indicating the end of the rectangle area indicates the rectangle area, and the portion between the <dc:description> tag and the </dc:description> tag indicates the attached information of the area.

Annex K. [Normative]
Original Preservation Image

K.1 Concept and Purpose

An original preservation image is an image that records the image at the time of capture separately from the primary image (at an equal or reduced size), and is applied only to compressed files that store JPEG compressed data.

Exif image files basically have a primary image and a single thumbnail that is a scaled-down version of the primary image and, until Exif 2.32, were limited to that configuration. In a case in which the original image recorded at the time of capture is processed in post-processing by image processing software, the thumbnail image is naturally different from the original image because it is linked to the primary image.

On the other hand, from the viewpoint of recording the original image to show authenticity, that is, that it is not a fake image, such as with a news photograph, it is effective to record and retain the original image, which does not reflect subsequent image processing, in the Exif image file separately from the primary image and the thumbnail of the primary image.

The original preservation image is intended to add credibility to the primary image by retaining a record of the original image when it is necessary to accurately indicate the information at the time of image capture.

K.2 Specifications

K.2.1 Overview

The data structure of a Baseline MP file specified in the MPF standard[3], another CIPA-issued standard, is used to record the original preservation image in a compressed file by used with additionally specifying a new type of an individual image. A Baseline MP file is itself an Exif compressed file of this standard and specifies MP format attribute information and the file format for additionally recording other Exif compressed images in association with the primary image (specified as the Baseline MP primary image in the MPF standard[3]). Thus, additional images based on the specification are recorded in addition to the primary image in the Exif compressed file.

K.2.2 General Rule

A compressed file that includes an original preservation image shall conform to the MPF standard[3], except as specified in section K.2.3 and subsequent sections in this annex.

K.2.3 Definition of Terms

K.2.3.1 Original Preservation Image

An image that records the image at the time of capture separately from the primary image, at an equal or reduced size.

Note Note the proviso of 1. in section K.2.12.

K.2.4 Option

The original preservation image is optional. Further, the Exif/DCF Reader does not need to reproduce the original preservation image.

K.2.5 Individual Image Attribute

In this specification, an original preservation image (ID code 040000) is defined as an MPF individual image type (see Table 4, "MP Types" in section 5.2.3.3.1 of the MPF standard[3]).

Note that, the MPF standard prohibits the use of types other than those in Table 4 described above as reserved, but this is not a restriction herein and is independently specified by Exif.

Table 69 lists the MP types including the types defined in this specification.

Table 69 MP Types

Type Information	Subdivision	Note	ID Code (Hex)
Baseline MP primary image			030000
Large thumbnail	Class 1	VGA equivalent	010001
	Class 2	Full HD equivalent	010002
Original preservation image			040000
Multi-frame image	Panorama		020001
	Disparity		020002
	Multi-angle		020003
Undefined type			000000

K.2.6 Baselin MP File

In this specification, types for which a Baseline MP file can be recorded include one original preservation image (as a result, the maximum number of individual images including the Baseline MP primary image and two monitor display images is four). For Baseline MP file specifications, see section 6.1 of the MPF standard[3].

Note that, in the MPF standard, the maximum number of individual images is defined as three, but this is not a restriction herein and is independently specified by Exif.

Note Mentions in the preceding section and this section to the provisions independently specified are as of the publication of Exif 3.0, and will be considered invalid if adjustment is made at the time of revision of the MPF standard[3].

K.2.7 Dependent Relationship

An original preservation image is recorded as a dependent image of the Baseline MP primary image. One original preservation image is dependent on one Baseline MP primary image.

K.2.8 Specification Related to MP Format Attribute Information

An original preservation image shall not record APP2 which includes MP format attribute information.

K.2.9 Padding

Padding in accordance with section 4.8.1 is permitted only when the number of pixels in the original preservation image does not match the MCU magnification of JPEG compression specified in this Exif standard.

K.2.10 Exif Thumbnails

The thumnail (see section 4.5.8) in APP1 in the header of an individual image that is an original preservation image shall not be recorded.

K.2.11 Number of Pixels

The recommended number of pixels of an original preservation image is 1080 or greater for the short side or 1920 or greater for the long side. In addition, the image shall comply with the following specifications.

K.2.12 Sameness with Baseline MP Primary Image

An original preservation image shall comply with 1 to 3 below to ensure sameness with the Baseline MP primary image

1. An original preservation image generated in association with photography is an image having the same angle of view and signal level (for a scaled-down image, a proximate average signal level for the corresponding pixel coordinates) as those of the Baseline MP primary image, and shall match the aspect ratio, image orientation, and color space of the Baseline MP primary image.
   However, if the Baseline MP primary image has been subjected to extreme image processing that manipulates the facts of the captured sceen, the image shall match the image captured before the image processing was applied.
2. The description level of the Exif tag in 1. above is specified in K.2.13. In particular, for the image unique ID (see section 4.6.6.9.1), the same value shall be recorded for the image unique ID of the Baseline MP primary image.

3. In post-processing of the Exif image file, the original preservation image shall be maintained. However, it may be deleted when unavoidable for reasons such as the protection of personal information.

   The term "maintained" here means that the original preservation image is to remain completely unchanged, including the Exif tags, if existent, or not to be newly recorded if non-existent. The term "deleted" means that the entire original preservation image, including the Exif tags, is to be deleted; partial deletion is not permitted.

K.2.13 Exif Tag Description Level of Original Preservation Image

The Exif tag description level of an original preservation image shall comply with 1 to 3 below.

Note Note that "Exif tag" in this annex means "a tag specified by Exif and DCF in APP1 in an individual image" as indicated in Chapter 7 of the MPF standard[3].

1. The following four tag description levels are mandatory.
   - Date and time of generation of original image data [DateTimeOriginal] (See section 4.6.6.6.1.)
   - Offset data of DateTimeOriginal [OffsetTimeOriginal] (See section 4.6.6.6.4.)
   - Sub-seconds of DateTimeOriginal [SubSecTimeOriginal] (See section 4.6.6.6.7.)
   - Image unique ID [ImageUniqueID] (See section 4.6.6.9.1.)
2. The following four tag description support levels described in Table 13, "Interoperability IFD Description Support Levels," of DCF[2], section 4.7, are optional.
   - Interoperability version [InteroperabilityVersion]
   - Related image file format [RelatedImageFileFormat]
   - Related image width [RelatedImageWidth]
   - Related image length [RelatedImageLength]
3. Tag description levels other than the above shall be the same as the tag description levels of Exif primary image (See the "Compressed" columns of Table 17, Table 18, Table 19, and Table 20 in section 4.6.9.)

Participating members

The bulk of the deliberations over the formulation of the standards described in this document was performed by the Exif/DCF Working Group. The members of the Working Group are listed below.

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